The Apprentice's Companion for Life Science

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Contents

Activity 1 Experiments and the Scientific Method

Factors Affecting Seed Sprouting

Today's Date _____

General Information

Life Science text reference: Chapter 1, Sections 1.3, 1.4

Estimated Time: 50 minutes to set up experiment; 5 minutes observation and note taking daily

Objectives

- Practice applying the Scientific Method.
- Form a testable hypothesis and design an experiment.
- Make conclusions based on data you collect.

Skills

- Sketching observations
- Labeling tables

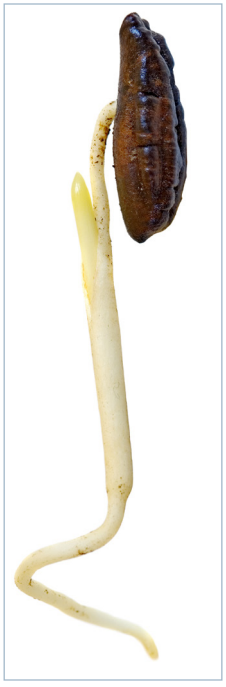
Introduction

Chapter 1 of *Life Science* describes the Cycle of Scientific Enterprise, and how the "scientific method" applies to conducting scientific experiments. In this activity, you put the steps of the scientific method into practice as you investigate one factor that might affect the sprouting of seeds.

A new gardener who wants to plant a row of green beans and a row of corn might consult the back of the seed package to learn how deep to plant the seeds in the soil, how far apart the seeds should be planted, and how often they should be watered. In order to sprout, seeds must have moisture and warmth. Your task is to investigate whether seeds sprout better in darkness or in light.

Materials (per student)

- dried beans (6)
- popcorn kernels (6)
- paper towels (8)
- black construction paper (2 pieces)
- small Ziploc bags (4)
- water
- tape
- small centimeter ruler



Though I do not believe a plant will spring up where no seed has been, I have great faith in a seed. Convince me that you have a seed there, and I am prepared to expect wonders.

—Henry David Thoreau, from *The Dispersion of Seeds*

Procedure

Hypothesis

1. Form a hypothesis that predicts whether seeds sprout better in darkness or in light. Write your hypothesis as an if-then statement, as represented by these examples:
   - If the coffee is especially sweet, then more children will want to drink it.
   - If the snowpack is not thick enough by spring, then the valley will have little water this summer.

Our Hypothesis

_____

_____

_____

Testing Method

2. Determine how you will test your hypothesis by designing an experiment using the materials provided. Some things to consider include how you will manipulate the variable you are testing (darkness or light), how your procedure will incorporate multiple trials, how you will keep all other conditions constant, what each member of your team will be doing, and how you will collect and record data from your experiment.
3. Write your experimental procedure in the space below. List the measurements you will make, the conditions you will control, and the data you will collect. Write your experimental design clearly so that another team could read it and repeat the experiment as you plan to do it.

Our Experimental Procedure

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Conduct Your Experiment and Collect Data

4. Following the procedure you designed, conduct your experiment. Use the space below to sketch your observations. Label your sketches with the date and time of your observations.
5. Create data tables in the grid area below. Label the trial number, the variable you are testing and measuring in each trial, and the values of the measurements (with units of measure).
6. As you conduct your experiment, collect data and record them in the data area.

Sketches

— Experimental Data —

7. After you have completed collecting data, use this section to describe your data and to consider how they relate to your hypothesis. Include these ideas:
   - What variable did you manipulate to determine its effect on seed sprouting?
   - What did you find? How do the data show this?
   - Were you surprised by what you found?
8. Explain whether your hypothesis was confirmed, spell out what you learned, and judge whether your results were definitive or inconclusive.

Our Analysis, Discussion, and Conclusion

What is commonly called a weed

What is commonly called a weed
has pushed, wriggled and writhed
through a fissure in the concrete pavement,
seeking sunshine, photosynthesis, survival.
The tendril is weak, fragile, vulnerable,
its very being tenuous but, that stem
extruding from where its seed was blown,
accidently washed or lodged,
proclaims nature will one day reclaim its own.
Its roots will create cracks that, in turn,
will receive other migrant seeds or spores.
Organisms that will grow and expand,
crumbling the concrete around it into sand.

—Jeremy Gadd

Exercises

1. Use the table below to describe how your experiment followed the steps of the scientific method. Refer to Table 1.1 in Chapter 1 of *Life Science* for an example of a table like this.

Step	Task	Remarks
1	State the problem.	
2	Research the problem.	
3	Form a hypothesis.	
4	Conduct an experiment.	
5	Collect data.	
6	Analyze the data.	
7	Form a conclusion.	
8	Repeat the work.	

2. Write a theory statement that explains the need for light in sprouting seeds.

_____

_____

Activity 2 Classifying Statements

Truth vs. Scientific Facts

Today's Date _____

General Information

Life Science text reference: Chapter 1, Sections 1.5, 1.6

Estimated Time: 10 minutes

Objectives

- Practice classifying truth statements.
- Practice identifying scientific facts.

Skills

- Distinguishing between scientific facts and truth claims

Introduction

Chapter 1 of *Life Science* describes the difference between scientific facts and theories. The chapter also describes three ways we can know truth. In this activity, you practice classifying truth statements and scientific facts.

Procedure

Truth vs. Scientific Facts

1. With a partner, discuss the ideas that you read about in Sections 1.5 and 1.6. Working together, come up with three truth statements based on direct observation and three scientific facts. Write your ideas in the table below.

Truth Statements	Scientific Facts
When I drop this rubber ball on the sidewalk, it bounces.	Onion root tips contain actively dividing cells.

2. Next, write a statement that describes the difference between a truth statement and a scientific fact.

_____

_____

Syllogisms

3. Invent your own syllogism. Label the lines below as the two premises and conclusion. Be sure the premises are true (as well as you can), and that the logic is valid.

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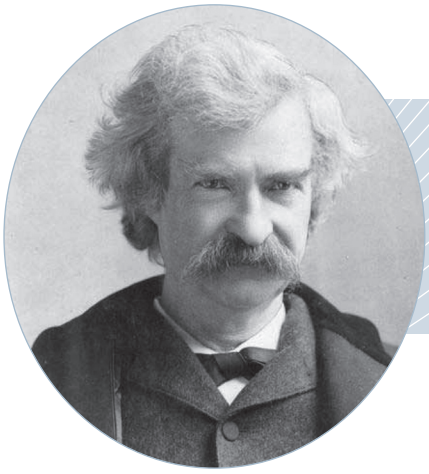

If you tell the truth, you don't have to remember anything.

— attributed to Mark Twain

— Commonplace Space —

Activity 3 Collecting, Preserving, and Mounting Specimens

Flowering Plants, Tree Leaves, and Insects

Today's Date _____

General Information

Your teacher may assign one or more of three collection activities. See the Appendix for more complete instructions.

Estimated Time: two or more hours outside of regular class

Introduction

Students of life science can find much value in the practice of collecting flowering plants, insects, or tree leaves. Collections help students develop skills in observation and classification. Many well-known scientists began to develop their interests and skills through collecting as children. Carl Linnaeus, the Swedish botanist known for developing a system for naming, ranking, and classifying organisms, showed great interest in plants when he was very young. William Smith, the English geologist who first mapped the strata of England, enjoyed collecting fossilized sea urchins and brachiopods as a schoolboy. Beloved children's book illustrator Beatrix Potter displayed a keen interest in natural history and devoted much time to drawing and painting fungi. Collections and sketches of flora and fauna have also been important in historical expeditions such as the voyages of Captain Cook and the Lewis and Clark expedition. Today, biologists refer to organized collections of dried plants (*herbariums*) to help them determine the range of certain species, that is, the region to which the species is native.

Objectives

- Become more aware of the plants and insects growing and living around you.
- Make connections between your local environment and our study of living things.
- Become familiar with taxonomy.

Materials (per group of 2)

- See the Appendix

Procedure

Review the Appendix and decide which of the three collecting projects you will complete. You may choose to complete more than one project if you desire. Keep in mind that collections of living organisms are easier to accomplish while the weather is warm. Record your choice below. Also, describe your general plan for completing this project, including the timeframe and some dates for completing major milestones.

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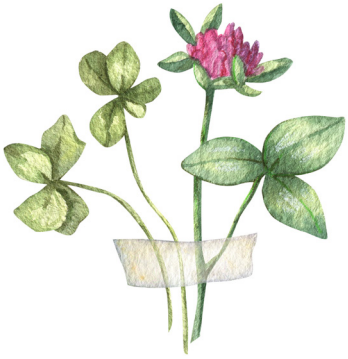
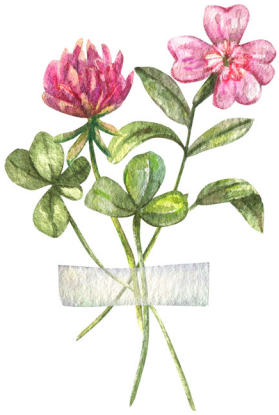
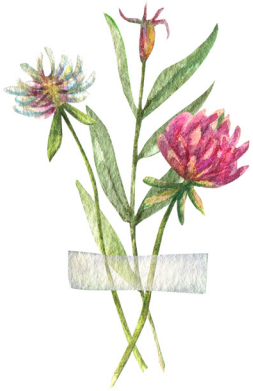
— Commonplace Space —





The lily has an air,
And the snowdrop a grace,
And the sweetpea a way,
And the heartsease a face,—
Yet there's nothing like the rose
When she blows.

—Christina Rossetti



Activity 10

Modeling Mitosis

The Phases of the Cell Cycle

Today's Date _____

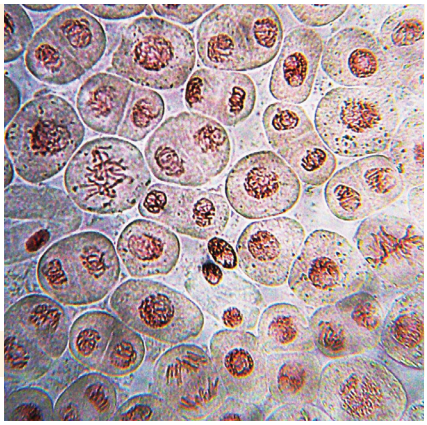
General Information

Life Science text reference: Chapter 4, Section 4.1

Estimated Time: 30 minutes

Introduction

The cell theory states that all living things are made of one or more cells and that all living cells arise from pre-existing cells by division. Mitosis, the process by which most cells multiply, is continuous. A cell moves from prophase through telophase in about two hours. The image at the right is from a slide of an onion root tip through a microscope. If you look closely, you can find cells in various stages of mitosis. In this activity, you make a model of the cell cycle.



Objectives

- Describe each phase in the cell cycle.

Skills

- Designing a model
- Interpreting images

Materials (per group of 2–4)

- fine yarn or crewel embroidery thread (several colors)
- scissors
- glue stick
- card stock
- pen

Procedure

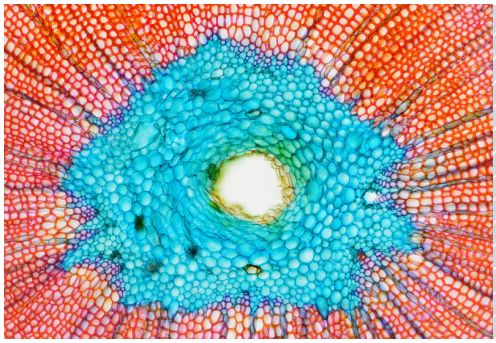
1. The stages of mitosis are described in *Life Science* Section 4.1 and Figure 4.2. Refer to these as needed.
2. Using the colored yearn and cardstock, create a model representing the five steps in the division of a cell nucleus with three pairs of chromosomes. (Human cells have 23 pairs of chromosomes, but a model with 46 chromosomes would be rather crowded!) Your model must include the five phases of the cell cycle: interphase, prophase, metaphase, anaphase, and telophase. Label your model. Include a brief description of each phase in the cell cycle.

Research

Research the number of chromosomes in the cells of some other organisms. Begin with fruit flies and then choose several other organisms. Record your findings in the table. Do you think the number of chromosomes gives some indication about how complex an organism is? Explain your answer.

Number of Chromosomes per Cell	
Species	**Number of Chromosomes**
humans	46
fruit flies	

— Commonplace Space —



I'd heard that life was cellular, in the body and outside the body. Nobody'd ever put it in so many words, but I kept hearing something that made me see that life was cellular. (Even the Communists have cells.)

—Robert Frost

Activity 16

Gravitropism

Plants and Gravity

Today's Date _____

General Information

Life Science text reference: Chapter 6, Section 6.3

Estimated Time: 10 minutes initial setup, 5 minutes for observation each day for several days, and 10 minutes on the last day

Introduction

In this activity, you observe geotropism, also called gravitropism—growth in response to the force of gravity.

Objectives

- Observe the reaction of a plant sensory system to the force of gravity.

Skills

- Observation and sketching

Materials (per group of 2–4)

- small glass jars with lids (2)
- paper towel
- radish seeds
- clear tape
- pencil
- water

Procedure

Note that lighting conditions are not important during either phase of this activity.

Germination of Seeds

1. Fold a paper towel in half four times to make 16 layers. Press the top of your small glass jar firmly into the paper towel layers to leave a circular indentation. Cut around the circle. Push the 16 layers of paper towel into the bottom of your small glass jar.
2. Soak the layers with water. Drain any excess water from the jar. Sprinkle four radish seeds on top of the paper towels. Seal the jar with the lid. Set the jar in a safe place until the seeds germinate. Seedlings are ready for the next phase when root hairs are visible.

Geotropism

3. Put a small amount of water in a second small glass jar and lay the jar on its side so that the water pools along the side of the jar but doesn't spill out.
4. Pick out a seedling with root hairs from the germination jar. Insert the seedling into the jar top first and lay it in the water.
5. Slowly tip the jar upright. You want the seedling to stick to the side of the jar so that it is upside down and out of the water. Close the lid tightly to prevent the water from evaporating.
6. Fasten a piece of clear tape to the outside of the jar. Trace the outline of the seedling onto the tape as a reference. Also, make a nice sketch of the seedling in the sketch area labeled Before.

7. Set your jar in a safe place and wait for 24 hours.
8. Make another nice sketch of your seedling to show how it looked after 24 hours.

Before Sketches After

9. Describe how your seedling grew in response to gravity.

_____

_____

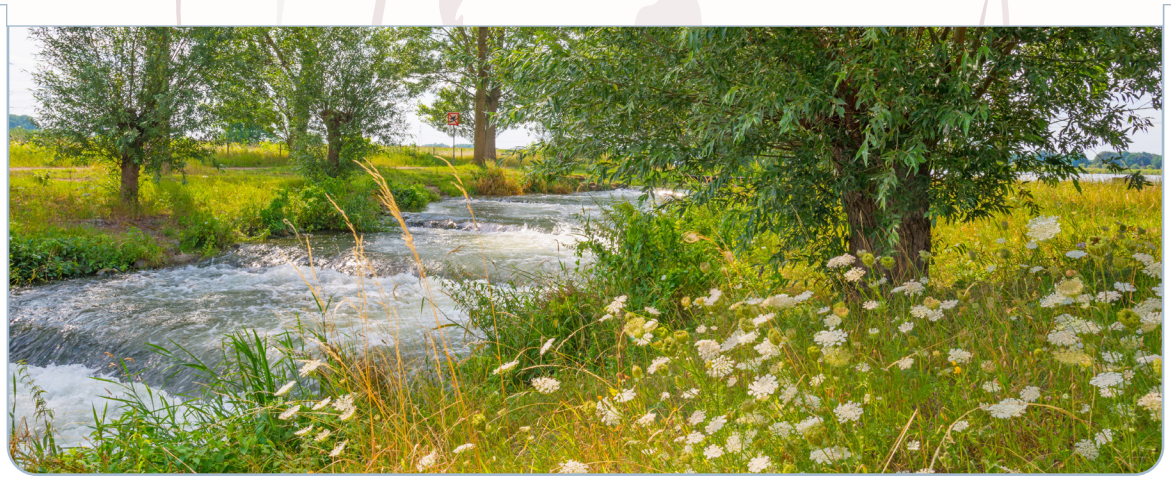
_____

_____

The Tuft of Flowers

I went to turn the grass once after one
Who mowed it in the dew before the sun.
The dew was gone that made his blade so keen
Before I came to view the levelled scene.
I looked for him behind an isle of trees;
I listened for his whetstone on the breeze.
But he had gone his way, the grass all mown,
And I must be, as he had been,—alone,
"As all must be," I said within my heart,
"Whether they work together or apart."
But as I said it, swift there passed me by
On noiseless wing a bewildered butterfly,
Seeking with memories grown dim o'er night
Some resting flower of yesterday's delight.
And once I marked his flight go round and round,
As where some flower lay withering on the ground.
And then he flew as far as eye could see,
And then on tremulous wing came back to me.
I thought of questions that have no reply,
And would have turned to toss the grass to dry;
But he turned first, and led my eye to look
At a tall tuft of flowers beside a brook,
A leaping tongue of bloom the scythe had spared
Beside a reedy brook the scythe had bared.
I left my place to know them by their name,
Finding them butterfly weed when I came.
The mower in the dew had loved them thus,
By leaving them to flourish, not for us,
Nor yet to draw one thought of ours to him.
But from sheer morning gladness at the brim.
The butterfly and I had lit upon,
Nevertheless, a message from the dawn,
That made me hear the wakening birds around,
And hear his long scythe whispering to the ground,
And feel a spirit kindred to my own;
So that henceforth I worked no more alone;
But glad with him, I worked as with his aid,
And weary, sought at noon with him the shade;
And dreaming, as it were, held brotherly speech
With one whose thought I had not hoped to reach.
"Men work together," I told him from the heart,
"Whether they work together or apart."

—Robert Frost



— Commonplace Space —