# Saguaro Germination Unit Summary (5th Grade)

**Unit Summary**: This is a five (or six or seven)-lesson unit in which students will read about the life cycle of the saguaro. They will then execute an investigation after posing a scientific question about saguaro seed germination rates and writing procedures/methods for their experiment. Once experiments have been completed, each group of students will compile data and compare results. Students will create a line graph of their results. Lastly, students will share science posters that summarize their discoveries and results.

Lesson Summaries:

**Lesson 1**: Teacher introduces unit of study to students. In this first lesson, students will use multiple sources to research the life cycle of the saguaro in order to give them background knowledge to ask an interesting scientific question and a hypothesis they can justify. Students will also use texts to answer specific questions.

**Lesson 2**: Students will write their question, hypothesis and work together with their group to collaboratively write the same procedures for their investigation. Once procedures have been approved, students will begin staging their investigation using saguaro seeds. *(Actually setting up their experiment may require an entire other class period depending on students' ability to effectively and efficiently design and write out their experiments)*

**Lesson 3**: Class will compile germination rates. Students will compare germination rates of their control group to their experimental group by representing each germination rate using grid paper and number lines. They will write equivalencies of their germination rates. They will use symbols to show greater than, less, than or equal, and also compare germination rates to benchmark decimals such as 0.25, 0.5, 0.75, and 1.

**Lesson 4**: After four weeks of recording data of germination rates once per week, students will graph their data on a double line graph using ordered pairs.

**Lesson 5:** Students will compile all their findings onto a poster, which will include their question, hypothesis, procedures, data tables, graphs, and conclusions. *(This may require an extra class period)*

# Ecology Integration Lesson Plan

## Saguaro Germination
## Part 1: Life Cycle of the Saguaro

Teacher: Grade Level: 5 Date:
Author: Wes Oswald

| | |
|---|---|
| **Common Core Standard:** | ELA 5.W.7: Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.<br><br>ELA 5.RI.7: Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5.RI.7) |
| **Ecology Objective:** | •Students will describe the life cycle of a saguaro and why it is considered both an indicator specie and a keystone specie of the Sonoran Desert |
| **Enduring Understandings and Essential Questions** | Interconnectedness (being joined or related): Organisms and their environments are interconnected; changes in one part of the system will affect other parts of the system.<br>•How is the saguaro interconnected with the plants, animals, and environment of the Sonoran Desert? |
| **Content Objective:**<br>*Math Reading Writing Other:* | •Students will conduct research about the life cycle of a saguaro cactus by reading multiple sources.<br>•Students will quickly and efficiently answer questions about the life cycle of a saguaro cactus through their research. |
| **Language Objective:** | |

| **Vocabulary** | **Materials** |
|---|---|
| Germination, seed, seedling, life cycle, pollinate/pollination, crested, nurse plant, precipitation, archaeological,<br>Indicator species, keystone species | •NPS pamphlets (*How to Grow a Saguaro Cactus* and *The Caguaro Cactus*) and additional books/reading material (selected from your library) about the saguaro's life cycle<br>•Saguaro seeds<br>•Life Cycle of the Saguaro worksheet (see accompanying documents) |

**Seasonality**: Saguaro seeds have a higher rate of germination when it is humid and warm outside, which is why it is important to do this toward the very beginning of the school year. However, using the greenhouse at another time of year may effectively replicate monsoonal conditions.

| *Monsoon*<br>July-Sept. | *Autumn*<br>Oct.-Nov. | *Winter*<br>Dec- Feb. | *Spring*<br>Mar.-Apr. | *Dry Summer*<br>May-June |
|---|---|---|---|---|

**Guiding Questions:** How can you use text features to help you efficiently answer your questions? How does _____ question relate to the saguaro's life cycle?

**Anticipatory Set:**

Describe all you know about how a saguaro lives, grows, and dies.

**Activity/Investigation:**

1. After reviewing responses from Anticipator Set, Teacher shows class the saguaro seeds and tells them that students will be researching the life cycle of the saguaro cactus today so they can get background information to write a scientific question about germination of the saguaro cactus and then write a hypotheses. Teacher shows students their research material and places students into small table groups. Teacher explains that good readers can use text features to help them find answers to questions. Teacher asks, "What are some text features that can help a reader navigate through a text efficiently?" Teacher shows students questions that are to be answered and asks students to write two of their own questions about the life cycle of a saguaro. Tell students their main focus is to efficiently look for answers in the text, not necessarily to read the whole thing. Students then work in their groups or individually to answer their questions. If students finish early, encourage them to read parts of the text that were skimmed over.

2. About midway through the research session, take a break for intermittent closure to pose the question, "What's the most interesting thing you've learned about the saguaro's life cycle so far?"

3. Teacher asks students to share the results of their research and the answers to some of their questions. Teacher will then show a short slide show (see accompanying file) and/or video about the saguaro and it's role as both ***keystone specie*** (a specie that plays an especially important role through its multiple connections to other members of its environment by providing food, shelter, etc.) and ***indicator specie*** (a species whose presence, absence, or relative well-being in a given environment is indicative of the health of its ecosystem as a whole) of the Sonoran Desert.
Video idea: http://channel.nationalgeographic.com/wild/the-wild-west/videos/secret-life-of-a-cactus/

4. Teacher then explains that next class session, students will use their knowledge gained today to write a scientific question they'd like to investigate about saguaro seed germination.

**Closure Questions:**

You learned a lot about the life cycle of a saguaro today.
a. What's the most surprising thing you learned today?
b. What is a new question you have about the life cycle of a saguaro?
c. What are some important text features you identified that allowed you to efficiently answer your questions?

**Teacher Reflection:**

# Ecology Integration Lesson Plan

## Saguaro Germination
## Part 2: Designing and Setting Up a Germination Experiment

Teacher: Grade Level: 5 Date:
Author: Wes Oswald

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|---|---|
| **Common Core Standard:** | ELA AZ 5.W.4: Produce clear and coherent functional writing (e.g., formal letters, recipes, experiments, notes/messages, labels, timelines, graphs/tables, procedures, invitations, envelopes) in which the development and organization are appropriate to task and purpose. |
| **Ecology Objective:** | •Students will use the scientific method to design an experiment about saguaro germination using a control and a variable. |
| **Enduring Understandings and Essential Questions** | **Interconnectedness** (being joined or related): Organisms and their environments are interconnected; changes in one part of the system will affect other parts of the system.<br>•How is the saguaro interconnected with the plants, animals, and environment of the Sonoran Desert?<br>**Climate**: (long standing weather patterns): Life on Earth depends on, is shaped by, and causes changes in climate.<br>•How does the climate of the Sonoran Desert affect saguaro seed germination? |
| **Content Objective:**<br>*Math Reading Writing Other:* | •Students will conduct research about the life cycle of a saguaro cactus by reading multiple sources.<br>•Students will quickly and efficiently answer questions about the life cycle of a saguaro cactus through their research. |
| **Language Objective:** | |

| **Vocabulary** | **Materials** |
|---|---|
| Controlled variable, independent variable, dependent variable, question, hypotheses, procedure, germination, seed, life cycle, nurse plant, precipitation, indicator species, keystone species | •cactus soil<br>•pots or trays<br>•plastic wrap |

**Seasonality** Saguaro seeds have a higher rate of germination when it is humid and warm outside, which is why it is important to do this toward the very beginning of the school year. However, using the greenhouse at another time of year may effectively replicate monsoonal conditions.

| *Monsoon* July-Sept. | *Autumn* Oct.-Nov. | *Winter* Dec- Feb. | *Spring* Mar.-Apr. | *Dry Summer* May-June |
|---|---|---|---|---|

**Guiding Questions:** What part of your experiment is the independent variabe?
What parts of your experiment will you make sure to control so that it is fair?
How could you vary the _____ in your experiment?

**Anticipatory Set:**

During our last class we read that the best way to germinate saguaro seeds is to:

> Plant them 1/8 inch deep in cactus soil in a pot with drainage holes, then place the pot in a warm sunny area and water every 10 days.

Since you know a bit about how saguaros grow, describe ONE of those steps you could change to try to help improve germination. (For example, instead of planting them 1/8 inch deep, I will place them right on top of the soil.)

**Activity/Investigation:**

1. Review responses from anticipatory set. Then teacher tells students that they will be doing the first steps today to start their saguaro germination experiment. Their challenge is to attempt to get better germination rates by changing ONE variable listed in the NPS pamphlet. Show students the materials they have to use including pots/trays, plastic wrap, cactus soil, etc. Tell students that with their group, they will plant two trays of saguaros—one exactly as NPS describes, and one where just one variable is changed (for example, the depth of planting, the amount of water or sun, presence or absence of drainage holes, type of soil, temperature, etc.) Each group will use exactly 50 saguaro seeds for each of their two trays. Their job today is to work with their group to agree on a question they can ask regarding their variable, write a hypothesis, and write their procedures. Once they have finished these tasks, they may begin their experiment.

2. Before allowing students to begin make sure they understand the following key words:

<table>
<tr><td colspan="3">Variable:<br>The part of an experiment that can change, such as amount of light, temperature, humidity, time changes, or plant growth</td></tr>
<tr><td>Controlled Variable/Control:<br>The parts of your experiment that do not change because you control them</td><td>Independent Variable:<br>The one part of your experiment that you change or manipulate</td><td>Dependent Variable:<br>The response or change that is measured because of your independent variable</td></tr>
<tr><td colspan="3">For example, let’s say you want to design an experiment to test whether the depth of the seed will improve germination. The control would be that you make sure that both sets of seeds receive the same amounts of water, light, temperature, etc.) The independent variable would be the new depth at which you plant seeds that vary from 1/8 inch. The dependent variable would be the response you measure, in this case the rate of germination. Did it change compared to your control group?</td></tr>
</table>

3. All groups must also create 2 data tables (one for their control group and one for their experimental group) in their journals in which they will record the number of seeds germinated (and still living) along with the week. They should record this data 4 times—once exactly one week after sowing seeds, and three more times each week thereafter. Their data tables should look something like this:

| **Control Group** | |
|---|---|
| Week Number | Number of seeds germinated and still |

| | living |
|---|---|
| Week 1 | |
| Week 2 | |
| Week 3 | |
| Week 4 | |

| **Experimental Group** | |
|---|---|
| Week Number | Number of seeds germinated and still living |
| Week 1 | |
| Week 2 | |
| Week 3 | |
| Week 4 | |

3. Table groups begin collaboration on writing their question, hypotheses, and procedures. Groups should reach consensus to have the exact same question and procedures since they will be doing the same experiment together. Their hypothesis of course, may differ from one another. Check each component of their methods before students progress to next steps.

**Closure Questions:**
A member of each group will share their question with the whole class. Next, students will do a gallery walk of sorts. Each student should have their question, hypothesis, and procedures set at their tables. Students will spend a couple minutes at each table reading and evaluating their classmates' work thus far. Upon completion, teacher asks students to nominate a set of procedures that they think are best and tell why.

**Teacher Reflection:**

# Ecology Integration Lesson Plan

## Saguaro Germination
## Part 3: Comparing Germination Rates

Teacher: Grade Level: 5 Date:
Author: Wes Oswald

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|---|---|
| **Common Core Standard:** | 5.NBT.3 Read, write, and compare decimals to thousandths.<br>a. Read and write decimals to thousandths using base-ten numerals, number names, and expanded form, e.g., 347.392 = 3 × 100 + 4 × 10 + 7 × 1 + 3 × (1/10) + 9 × (1/100) + 2 × (1/1000).<br>b. Compare two decimals to thousandths based on meanings of the digits in each place, using >, =, and < symbols to record the results of comparisons. |
| **Ecology Objective:** | •Students will observe the effects of their independent variables (simulated change of climate or natural growing conditions) on saguaro germination. |
| **Enduring Understandings and Essential Questions** | **Interconnectedness** (being joined or related): Organisms and their environments are interconnected; changes in one part of the system will affect other parts of the system.<br>•How did the saguaro seedlings show interconnectedness with the simulated/actual plants, animals, and environment of the Sonoran Desert?<br>**Climate**: (long standing weather patterns): Life on Earth depends on, is shaped by, and causes changes in climate.<br>•How did your simulation of a change to the Sonoran Desert's climate affect saguaro seed germination? |
| **Content Objective:**<br>*Math Reading Writing Other:* | •Students will represent and compare the germination rates of their control and experimental groups.<br>•Students will list from least to greatest the success rates of each groups' experimental group. |
| **Language Objective:** | |

| **Vocabulary** | **Materials** |
|---|---|
| Controlled variable, independent variable, dependent variable, germination, tenths, hundredths, thousandths, fraction, numerator, denominator, greater than, less than, equal | •experiment seed trays<br>•Hundredths and Thousandths Grids (see accompanying documents)<br>•Saguaro Germination Data Tables (see accompanying documents) |

**Seasonality** Saguaro seeds have a higher rate of germination when it is humid and warm outside, which is why it is important to do this toward the very beginning of the school year. However, using the greenhouse at another time of year may effectively replicate monsoonal conditions.

| *Monsoon* | *Autumn* | *Winter* | *Spring* | *Dry Summer* |
|---|---|---|---|---|
| July-Sept. | Oct.-Nov. | Dec- Feb. | Mar.-Apr. | May-June |

**Guiding Questions:** How do you say [name of decimal]?
Which representation more clearly allows you to compare decimals?
Where are the hundredths in your representation?
Where are the tenths in your representation?

***Note: Do this lesson only once four weeks of data collection have been completed!***

**Anticipatory Set:**

Draw a number line that contains the landmark numbers of:

0, 0.25, 0.5, 0.75, 1

Next, use your landmark numbers as guides to place the following numbers:

.31, .60, .06

Lastly, describe which landmark number each of the three numbers above is closest to and how you can tell.

**Activity/Investigation:**

1. After reviewing accurate responses from the Anticipatory Set… Tell students that today they will use their data tables in their journals to record their germination rates for both their control group and their experimental group. Distribute "Saguaro Germination Data Tables" worksheet or give students the opportunity to recreate (this is my preference as it forces students to find how the data table is organized and gives them time to understand the table) their own given the provided data table as a model.

2. Give students a lesson on decimals and finding equivalent fractions so they can accurately complete their Saguaro Seed Germination Data Table.
a. Review with students how to write a fractional part using a numerator and denominator as related to the fractional part of seeds germinated in each tray of their experiment.
b. Show students how you can change a fraction with a denominator of 50 (the number of seeds in each of their trays) into a fraction with a denominator of 100. Model this using hundredth charts.
c. Use a place value chart to show students where tenths and hundredths fall. Relate tenths to the value of a dime and hundredths to the value of a penny.
d. Review with students that a percent is based on a fractional part with a denominator of 100.

3. Once most students have completed their data tables, redirect their attention to the board so you can show students how you want them to represent their decimals on hundredth grids and number lines so they can compare the rates of their control group to that of their experimental group. Students will use the worksheet "Saguaro Germination Data Tables" to complete.

4. Have a chart on the board like this:

| Group Name: | Experimental Group Germination Rate after 4 Weeks: | Rank: |
|---|---|---|
| | | |
| | | |

| | | |
|---|---|---|
| | | |

As students complete their work, invite them to come to the board to record their groups' germination rates on the table. Then as a class, work together to rank (or rewrite in order) them in order from least to greatest.

5. Each group should select another group's experimental group's germination rates to compare their own to on the back of their "Saguaro Germination Data Tables" worksheet. Have available hundredths grids available for students to shade in and attach to their worksheets as models for germination rates.

**Closure Questions:**
What's the most important thing to remember when comparing decimals that have digits in the hundredths?

**Teacher Reflection:**

# Ecology Integration Lesson Plan

## Saguaro Germination
## Part 4: Creating Line Graphs Using Ordered Pairs to Show Germination Rates

Teacher: Grade Level: 5 Date:
Author: Wes Oswald

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|---|---|
| **Common Core Standard:** | **5.G.1** 1. Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., *x*-axis and *x*-coordinate, *y*-axis and *y*-coordinate). |
| **Ecology Objective:** | •Students will use a line graph to represent the effects of their independent variables (simulated change of climate or natural growing conditions) on saguaro germination.<br>•Students will interpret their line graph. |
| **Enduring Understandings and Essential Questions** | **Interconnectedness** (being joined or related): Organisms and their environments are interconnected; changes in one part of the system will affect other parts of the system.<br>•How did the saguaro seedlings show interconnectedness with the simulated/actual plants, animals, and environment of the Sonoran Desert?<br>**Climate**: (long standing weather patterns): Life on Earth depends on, is shaped by, and causes changes in climate.<br>•How did your simulation of a change to the Sonoran Desert's climate affect saguaro seed germination? |
| **Content Objective:**<br>*Math Reading Writing Other:* | •Students will use coordinate pairs to plot data on line graphs. |
| **Language Objective:** | |

| **Vocabulary** | **Materials** |
|---|---|
| Axes, coordinate system, origin, ordered pairs, coordinates, x-axis, y-axis | • Experiment seed trays<br>• Creating Line Graphs Using Ordered Pairs to Show Germination Rates (See accompanying documents) |

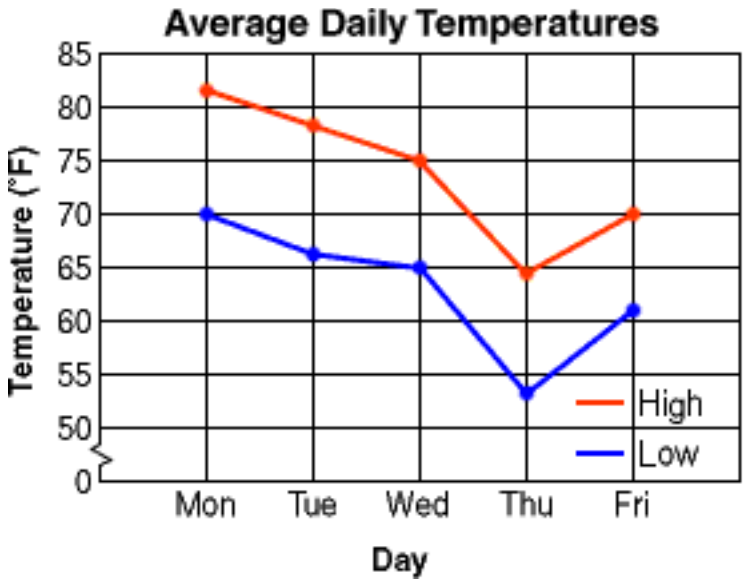
**Seasonality** Saguaro seeds have a higher rate of germination when it is humid and warm outside, which is why it is important to do this toward the very beginning of the school year. However, using the greenhouse at another time of year may effectively replicate monsoonal conditions.

| | | | | |
|---|---|---|---|---|
| *Monsoon*<br>July-Sept. | *Autumn*<br>Oct.-Nov. | *Winter*<br>Dec- Feb. | *Spring*<br>Mar.-Apr. | *Dry Summer*<br>May-June |

**Guiding Questions:** How does the graph help us interpret the results of your experiment?
Why are labels important for a graph?
What does this graph tell you about your results?

**Anticipatory Set:**

Study this double line graph:




a. What is this graph about?

b. Describe some things you notice about this graph.

**Activity/Investigation:**

1. After reviewing responses from the Anticipatory Set… Tell students that today they will represent the information in their data tables using a double line graph. Give students a lesson on line graphs, making sure touch on:

a. What line graphs are used for (to represent change over time)

b. The parts of a double line graph including title, labels, origin, key, x-axis, y-axis, and ordered pairs/coordinate pairs

c. Using invented data, model how to create a double line graph and how to list the ordered pairs.

2. Distribute graph paper (or have students tape graph paper into their journal and have them write conclusions in journal below graph) to students so they can create a double line graph of their data. Students will graph each of their four coordinates of number of seeds germinated for each of the four weeks. This double line graph will show the change of germination over time for their control group and their experimental group. Make sure students color code each line and create a key. Below their double line graph students should write a paragraph in which they interpret their graph. Here are some sample sentence starters:

I notice that….

I predict that…

If you look carefully at the graph, you will see that…

The saguaro in the _____ group had a higher rate of germination.

I think this group had a higher germination rate because…

**Closure Questions:**

Describe some organizational features of a line graph and some strategies someone could use to make a line graph easy to understand.

**Teacher Reflection:**

# Ecology Integration Lesson Plan

## Saguaro Germination
## Part 5: Culminating Science Posters

Teacher: Grade Level: 5 Date:
Author: Wes Oswald

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|---|---|
| **Common Core Standard:** | (Arizona does not use Next Generation Science Standards, so AZ State Standards are used here instead.)<br>*Strand 1, Concept 4, PO 1. Communicate verbally or in writing the results of an inquiry.*<br>*Strand 1, Concept 4, PO 3. Communicate with other groups or individuals to compare the results of a common investigation.* |
| **Ecology Objective:** | •Students will communicate the importance of the Saguaro Cactus as a vital part of the Sonoran Desert through their conclusions and/or background research of their investigation. |
| **Enduring Understandings and Essential Questions** | **Interconnectedness** (being joined or related): Organisms and their environments are interconnected; changes in one part of the system will affect other parts of the system.<br>•How did the saguaro seedlings show interconnectedness with the simulated/actual plants, animals, and environment of the Sonoran Desert?<br>**Climate**: (long standing weather patterns): Life on Earth depends on, is shaped by, and causes changes in climate.<br>•How did your simulation of a change to the Sonoran Desert's climate affect saguaro seed germination? |
| **Content Objective:**<br>*Math Reading Writing Other:* | •Students will communicate the results of their scientific investigation on a poster through writing, graphs, and pictures. |
| **Language Objective:** | |

| **Vocabulary** | **Materials** |
|---|---|
| Question, Background Research, Hypothesis, Methods, Data Table, Graph, Conclusions | •Poster boards or poster paper<br>• Art materials (markers, colored paper, tape, glue, etc.) |

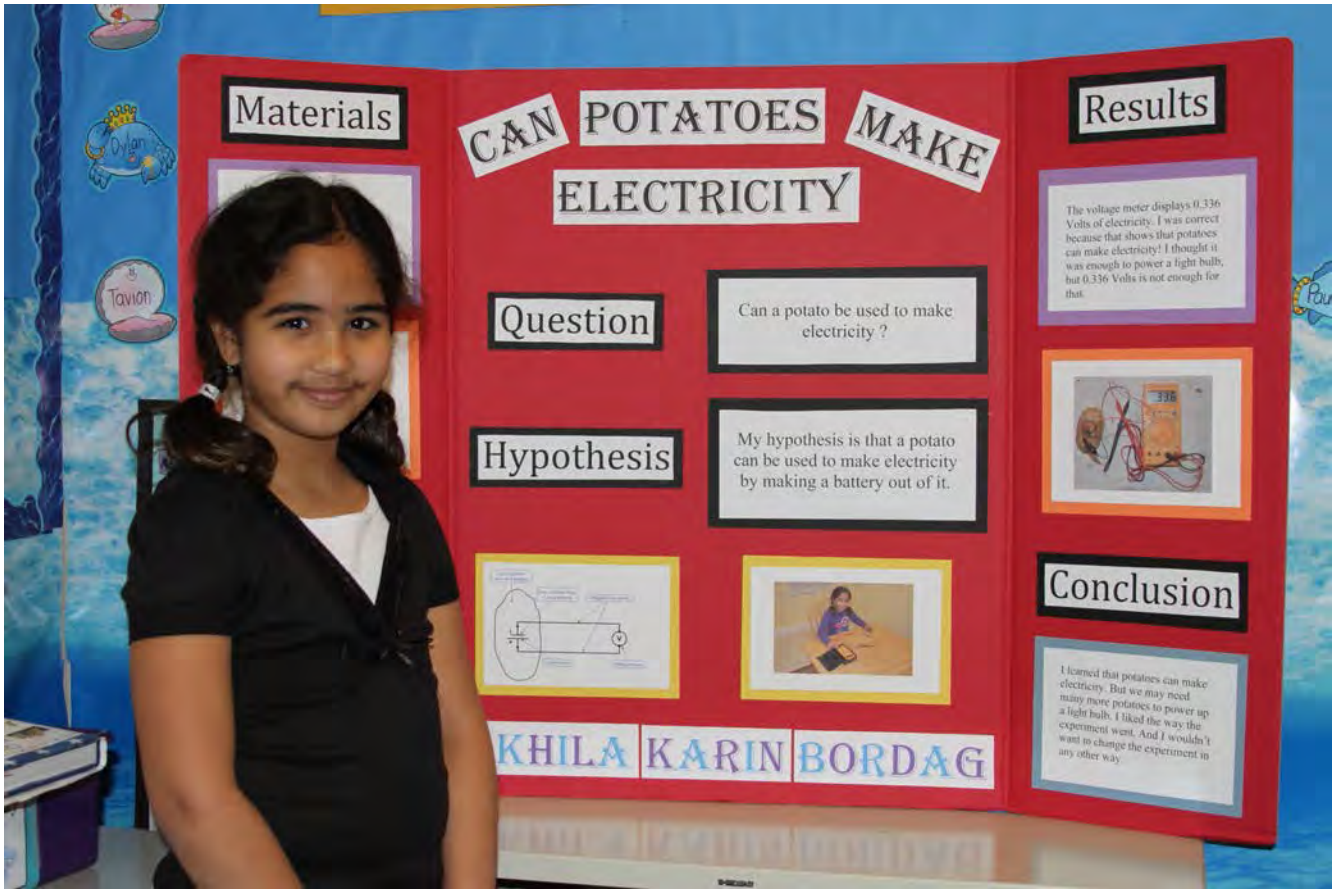
**Seasonality** Saguaro seeds have a higher rate of germination when it is humid and warm outside, which is why it is important to do this toward the very beginning of the school year. However, using the greenhouse at another time of year may effectively replicate monsoonal conditions.

| *Monsoon*<br>July-Sept. | *Autumn*<br>Oct.-Nov. | *Winter*<br>Dec- Feb. | *Spring*<br>Mar.-Apr. | *Dry Summer*<br>May-June |
|---|---|---|---|---|

**Guiding Questions:** How can you improve upon your first draft?
How can you best organize your poster?

**Anticipatory Set:**

Study this Science Poster.




a. Describe what makes this poster look visually appealing and organized.

b. Describe improvements you would make to this poster.

**Activity/Investigation:**

1. After reviewing responses from the Anticipatory Set… Tell students that today they will show the results of their investigation on a science poster. Show a few more examples from the internet or real life of student-created science posters. Discuss how each poster has a question, evidence of research, hypothesis, methods, data tables, graphs, conclusions and pictures, or some variation thereof. Write a list of all necessary parts on the board for students to reference. Additionally lead a discussion about what makes a poster look organized and visually appealing.

2. Next, decide whether you would rather students work individually on their posters, with a partner or with their whole investigation group (each has its plusses and minuses!) Then tell students that they have most of this information already created. Their question, hypothesis, data tables, and graphs are already complete. They can use their worksheet from lesson one to summarize their background research to explain why saguaros are such an important part of the Sonoran Desert. They can use some of their graph interpretations from lesson 4 as a basis for their conclusions. Note that in addition to interpreting data and graphs, scientific conclusions typically tell why their findings matter, what they learned from the experiment, what they would do differently if they were to redo their experiment, and whether or not their hypothesis was correct.

3. Students then create posters. This activity could lend itself to one more class period in which

students spend half of the class period finishing their posters and the last half summarizing their findings to the whole class or to small groups.

**Closure Questions:**
What was the most interesting discovery you made during our Saguaro Germination unit?

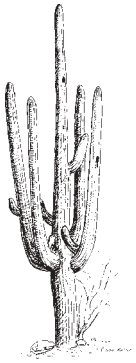
**Teacher Reflection:**

# Saguaro

U.S. Department of the Interior
National Park Service

Saguaro National Park

## How to Grow a Saguaro (Sa-wah-roe)



### The Saguaro Cactus *Carnegiea gigantea*

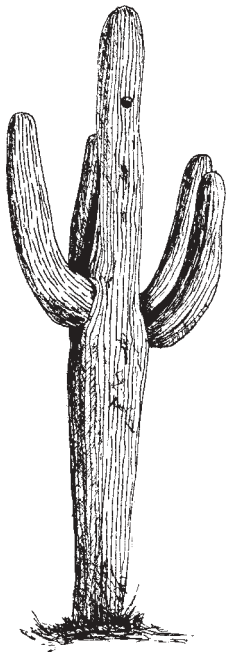
The saguaro is probably the most famous cactus in the world. Almost everyone has heard about this majestic symbol of the desert.

If you would like to grow a saguaro cactus in your home or classroom, all you have to do is follow the instructions below, and be very patient.

NOTE: Make sure that your saguaros are not exposed to freezing temperatures or they may die. If you do not live in a warm place like the Sonoran Desert, it is probably best to grow them indoors.

Remember, saguaros grow very slowly; be patient, have fun and do not over-water them.

### Growing Instructions



1) Pick a small to medium sized pot that has drainage holes in the bottom.

2) Fill the pot with soil that drains well, or buy a soil mixture that is specifically for cactus.

3) Using a sharp pencil, poke several small holes 1/8 inch deep into the soil. Space the holes at least 1 inch apart. Put one seed in each hole and lightly press a pinch of soil over each seed.

4) Cover the pot with clear plastic wrap and poke or cut several small holes in the wrap.

5) Place the pot in a warm, well-lit location, but make sure that the pot does not receive direct sunlight.

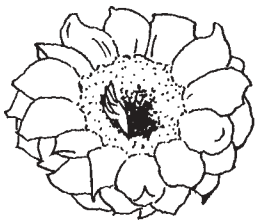
6) Keep the pot covered with clear plastic wrap for 4 to 6 weeks. Moisten the soil about every 10 days. Do not over-water!

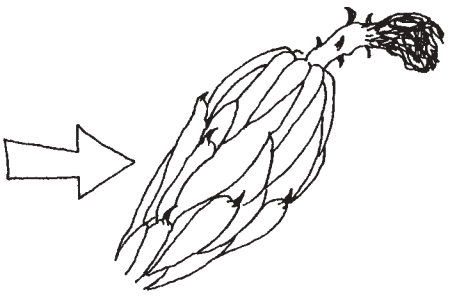
7) After removing the clear plastic wrap, you will only need to water about once per month. Do not over-water!

8) In about 1 to 2 years, you can transplant each saguaro to its own individual pot. They should be about 1 inch tall.

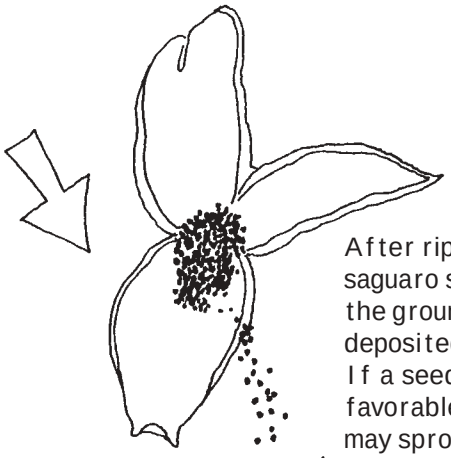
# Life Cycle of the Saguaro Cactus

Saguaro blossoms appear at night during May and June.

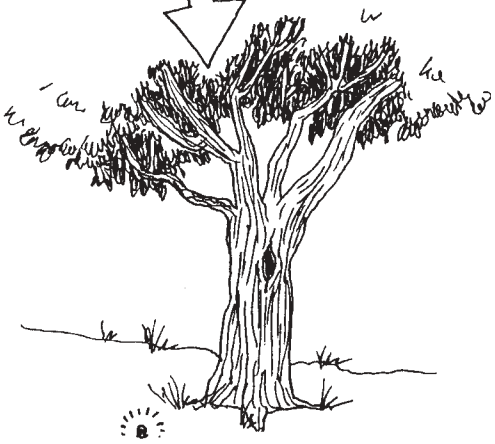




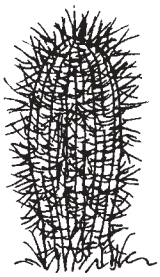
After pollination, each flower develops into a 1-2 ounce fruit. The fruits ripen in July, and each holds more than 2,000 tiny seeds!



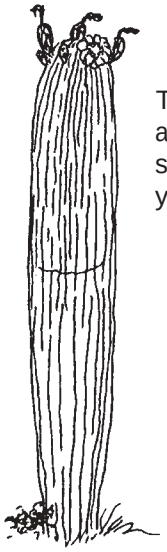
After ripening, the saguaro seeds fall to the ground, or are deposited by birds. If a seed falls in a favorable place, it may sprout and grow.



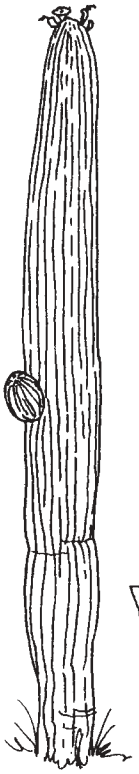
If a saguaro seedling is to survive, it needs the protection of a “nurse plant”.



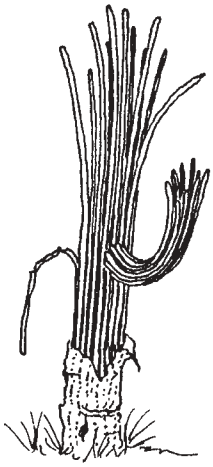
After its first year, the seedling’s highly variable growth is controlled by the amount of water in the soil.



The first blossoms appear when the saguaro is 35-40 years old.



The first arm on a saguaro usually appears when the plant is 65-70 years old.



Saguaro cacti normally live for 150 - 200 years. Death may come by freezing, lightning, wind, old age or vandalism.

# Saguaro Life Cycle Questions

1. What natural event helps **germinate** saguaro seeds? How?

2. Many saguaro **seedlings** die. Some don't. Where will the successful saguaro **seedlings** most likely be found? Why?

3. Describe one **connection** between the saguaro and an animal.

4. Describe two things that help the saguaro **reproduce** (make new saguaros).

5. _____?

6. _____?

# Saguaro Cactus: A Keystone Specie

This palo verde acts as a nurse plant to the young saguaros. How many saguaros is it protecting?

Not only is it Arizona’s state flower, but the white flower provides nectar to bats which help pollinate the saguaro causing it to produce fruit and seeds.


Sweet saguaro fruits don’t last very long with these doves around!

Historically, the saguaro fruit is a special food to Tohono O'odham people. Today, many people enjoy the tasty fruits. The tool they are using is made of a saguaro rib!

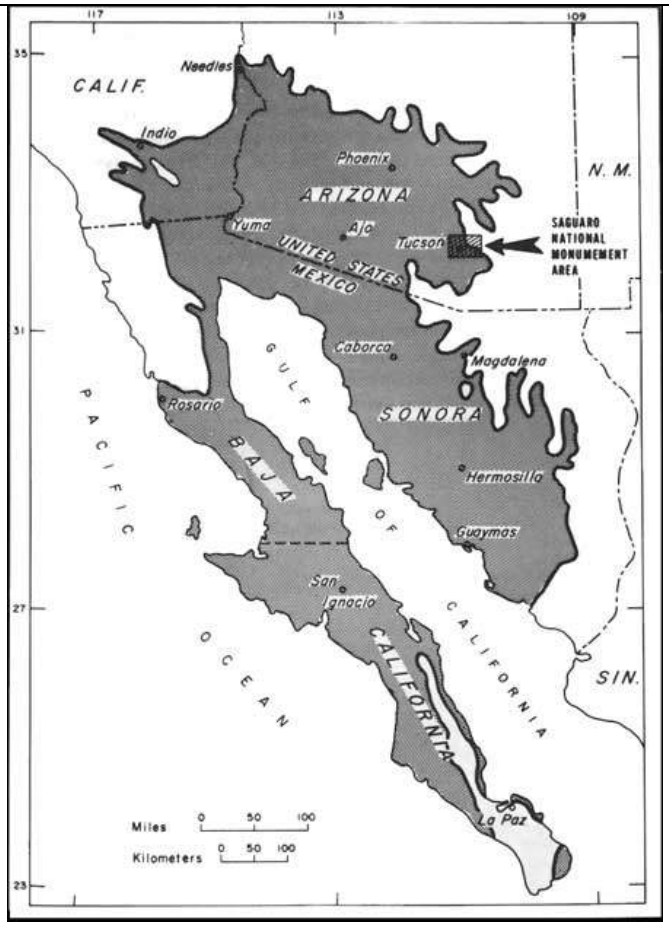
This Gila Woodpecker pecked this home in the saguaro. This bird is feeding a grub to its chicks inside.

Once the nest has been made and abandoned by a woodpecker, other birds like this ferruginous owl or maybe a pygmy owl will move in.

Harris hawks will construct huge nests among the arms of a saguaro to raise and protect their young.


Even in death, the saguaro contributes to its environment. Insects will feast on rotting flesh or it will amend the soil. Its ribs are used by people as a tool or building material.

# Saguaro Cactus:
# An Indicator Specie



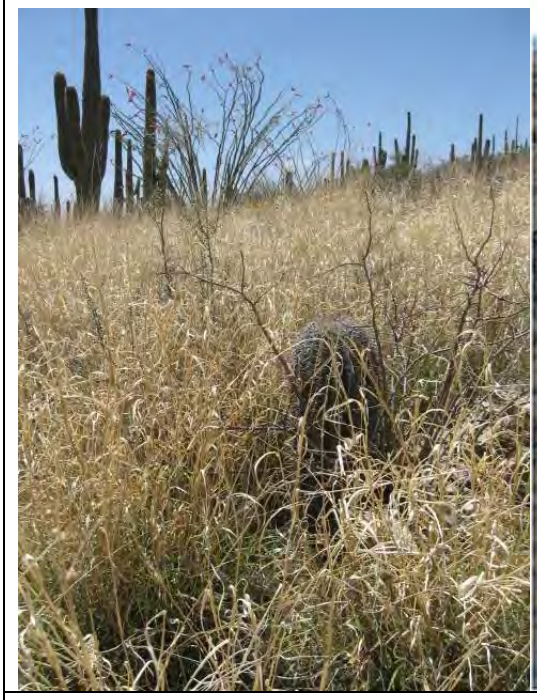

Map of the Sonoran Desert

Map of wild saguaro habitat

# What do you notice about these two maps?

Which looks like a healthier environment?

or…




Buffel grass creates an environment where fire becomes a possibility.

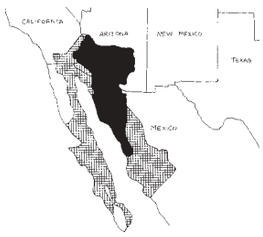
# Saguaro

U.S. Department of the Interior
National Park Service

Saguaro National Park

## The Saguaro Cactus

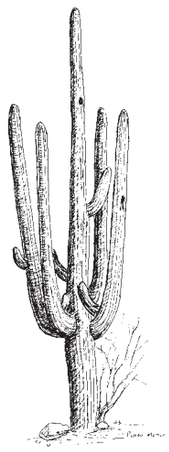
### Where do saguaros grow?




Saguaro cacti, *Carnegiea gigantea,* only grow in the Sonoran Desert. However, they do not grow in all parts of the Sonoran Desert. The map at left represents the range of the Sonoran Desert (crosshatch) with an overlay of the range of the saguaro cactus (solid). The range of the saguaro is limited by freezing temperatures in winter.

Saguaros are also limited by elevation. They are generally found growing from sea level to approximately 4,000 feet in elevation. Saguaros growing higher than 4,000 feet are usually found on south facing slopes where freezing temperatures are less likely to occur or are shorter in duration.

### How do saguaros grow?



Saguaros are a very slow growing cactus. In Saguaro National Park, studies indicate that a saguaro grows between 1 and 1.5 inches in the first eight years of its life.

These tiny, young saguaros are very hard to find as they grow under the protection of a “nurse tree”, most often a palo verde, ironwood or mesquite tree. As the saguaro continues to grow, its much older nurse tree may die. Some scientists believe that competition from the saguaro may lead to the death of the nurse tree by taking water and nutrients from the soil in the immediate area.

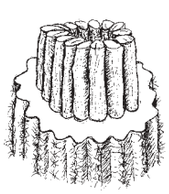
As a saguaro begins to age, growth rates vary depending on climate, precipitation and location. We do know that the period of greatest growth in a saguaro cactus is from unbranched to branched adult.

Here at Saguaro National Park, branches normally begin to appear when a saguaro reaches 50 to 70 years of age. In areas of lower precipitation, it may take up to 100 years before arms appear.

When a saguaro reaches 35 years of age it begins to produce flowers. Though normally found at the terminal end of the main trunk and arms, flowers may also occur down the sides of the plant. Flowers will continue to be produced throughout a saguaro’s lifetime.

An adult saguaro is generally considered to be about 125 years of age. It may weigh 6 tons or more and be as tall as 50 feet. The average life span of a saguaro is probably 150 - 175 years of age. However, biologists believe that some plants may live over 200 years.

### Why are saguaros pleated?



The roots of a saguaro grow out from the plant in a radial fashion, several inches under the ground. During a heavy rain, a saguaro will absorb as much water as its root system allows.

To accomodate this potentially large influx of water, the pleats expand like an accordion. Conversely, when the desert is dry, the saguaro uses its stored water and the pleats contract.

Because the majority of a saguaro is made up of water, an adult plant may weigh 6 tons or more. This tremendous weight is supported by a circular skeleton of inter-connected, woody ribs. The number of ribs inside the plant correspond to the number of pleats on the outside of the plant. As the saguaro grows, the ribs will occasionally fork and the corresponding pleat will also fork at the same place.

## Why are some saguaros crested?

Even when saguaro cacti grow in their normal form, they rarely grow symmetrically. Saguaros sometimes grow in odd or mis-shapen forms. The growing tip occasionally produces a fan-like form which is referred to as crested or cristate. Though these crested saguaros are somewhat rare, over 25 live within the boundaries of the park. Biologists disagree as to why some saguaros grow in this unusual form. Some speculate that it is a genetic mutation. Others say it is the result of a lightning strike or freeze damage. At this point we simply do not know what causes this rare, crested form.

## Do animals use the saguaro?

Gila Woodpecker

Saguaro cacti are host to a great variety of animals. The gilded flicker and Gila woodpecker excavate nest cavities inside the saguaro's pulpy flesh. When a woodpecker abandons a cavity, elf owls, screech owls, purple martins, finches and sparrows may move in.

Large birds, like the Harris's and red-tailed hawks, also use the saguaro for nesting and hunting platforms. Their stick nests are constructed among the arms of a large saguaro. In turn, ravens and great horned owls may take over an abandoned hawk nest.
Saguaro cacti also provide a valuable source of food for animals. In late summer, ripening fruit provides moisture and an energy-rich food during a time of scarcity.

In drier areas of the Sonoran Desert, pack rats, jackrabbits, mule deer and bighorn sheep will also eat the saguaro's flesh when other water sources are not available.

## How does the saguaro reproduce?

Lesser Long-nosed Bat

In late April through early June, the tops of the saguaro's trunk and arms sprout a profusion of large, creamy white flowers. Individual flowers open at night and close the following afternoon. To develop into fruits, they must be pollinated within this time frame. Pollination is carried out by nectar feeding bats, birds and insects.

Each fruit contains about 2,000 tiny black seeds. When the fruit and seeds are eaten by a coyote or cactus wren, the seeds pass through their digestive system unharmed and are distributed throughout the desert. However, if the seeds are eaten by a dove or quail, they will be completely consumed in the digestive system.

It is estimated that a saguaro can produce some 40 million seeds during its lifetime. However, few will survive to become a seedling. Fewer still will become an adult. The low survival rate of seedlings is due to drought, prolonged freezing and animals eating them.

## Do humans use the saguaro?

Archeological evidence indicates that the Hohokam used the saguaro in their daily life. The strong, woody ribs were gathered to construct the framework for the walls of their homes.

Additionally, saguaro ribs were used to collect saguaro fruits, which grow high up on the plant. Several ribs were tied together with a cross piece at the end. These long poles were used to knock ripe fruit down from the top of the plants. It would then be gathered to eat.

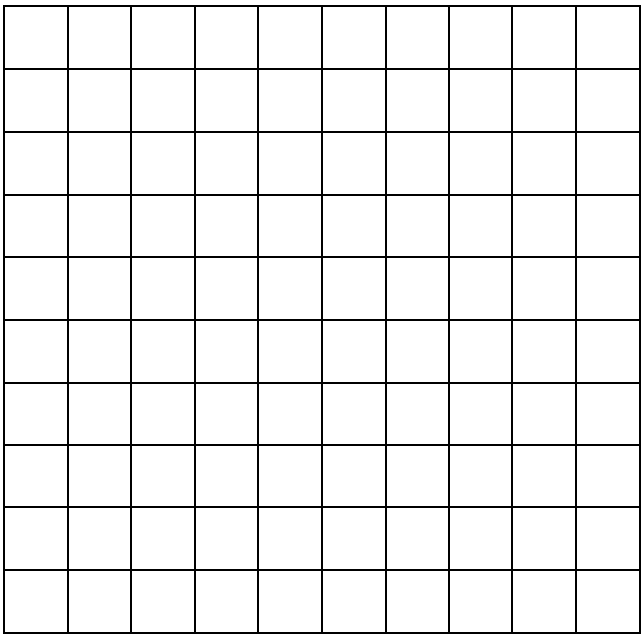
The Tohono O'odham continue to gather saguaro fruit in this manner. They use the sweet fruits to make ceremonial wine, jelly and candies. They also use the seeds as chicken feed.

## Are there threats to the saguaro?

Reports of a saguaro "disease", popularized almost fifty years ago, persist, but saguaros are not subject to blights. The saguaro is a long-lived cactus, most affected by long-term climate cycles of frost and drought. In actuality, the saguaro is a common plant in the Sonoran Desert, not an endangered species.

Without question, the biggest threat to the saguaro is our rapidly expanding human population. The development of new homes in the Tucson area has resulted in a tremendous loss of saguaro habitat. With this influx of people has come another threat to the saguaro-exotic plants. Exotic plants almost always out-compete native plants for the limited resources of water and nutrients. They have also led to an increase in wildfires, which harm or kill native vegetation, including the saguaro.

Hundredths Grid



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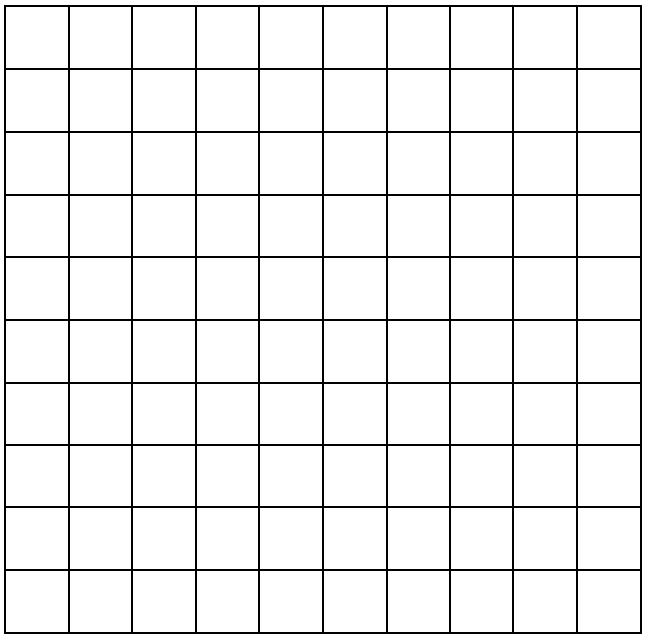

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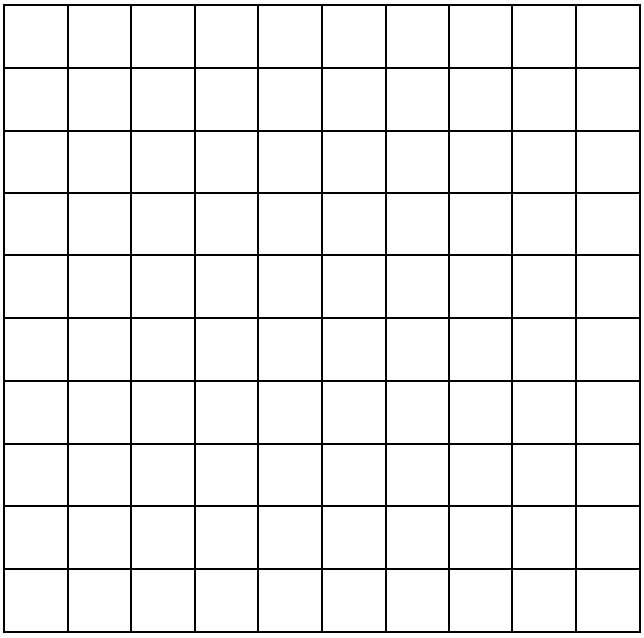

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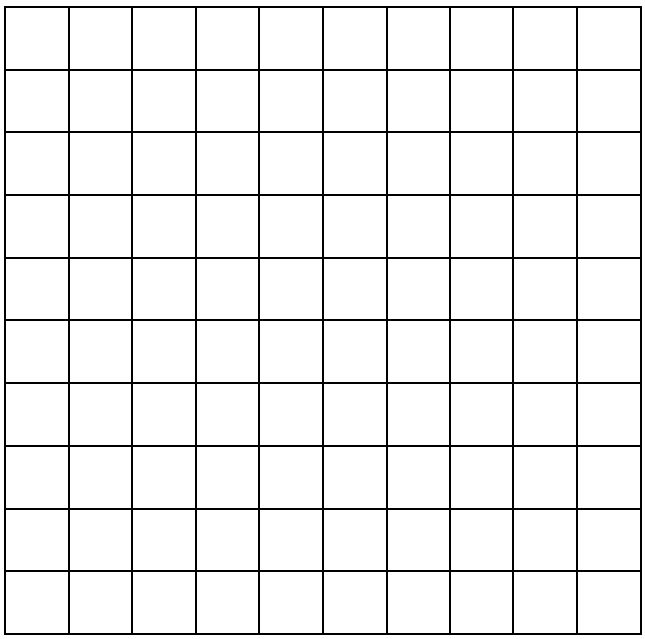

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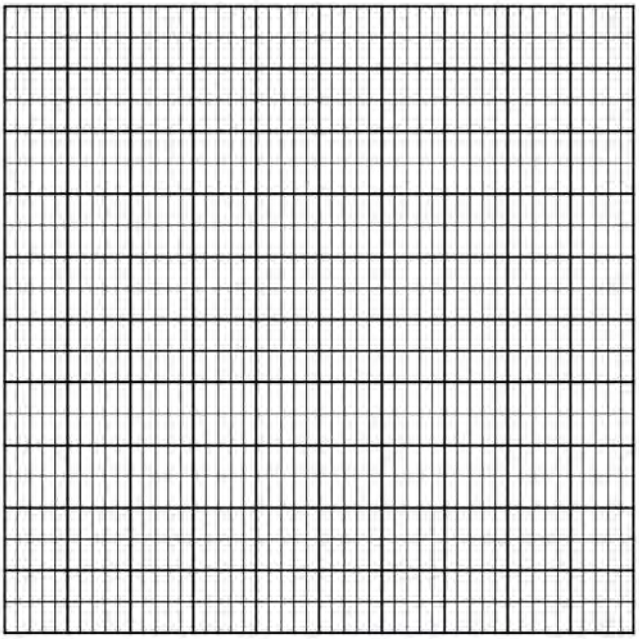



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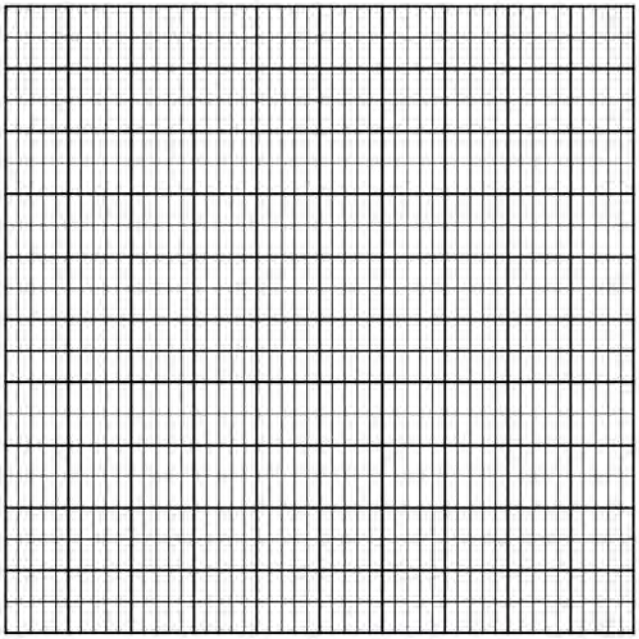

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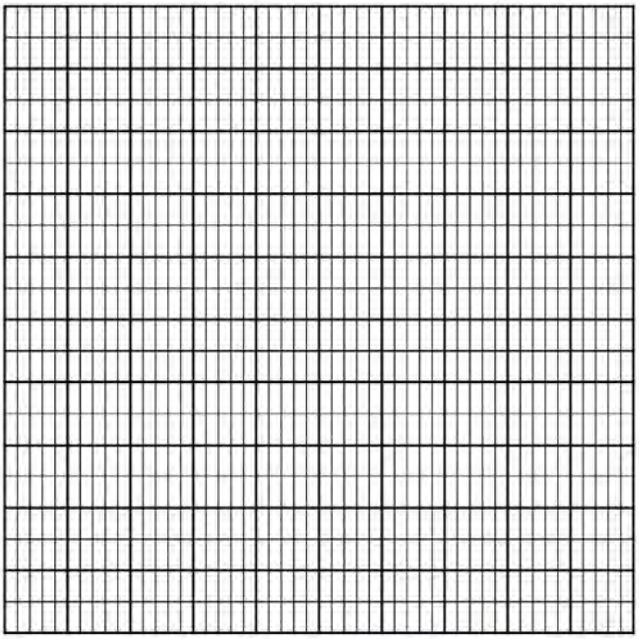

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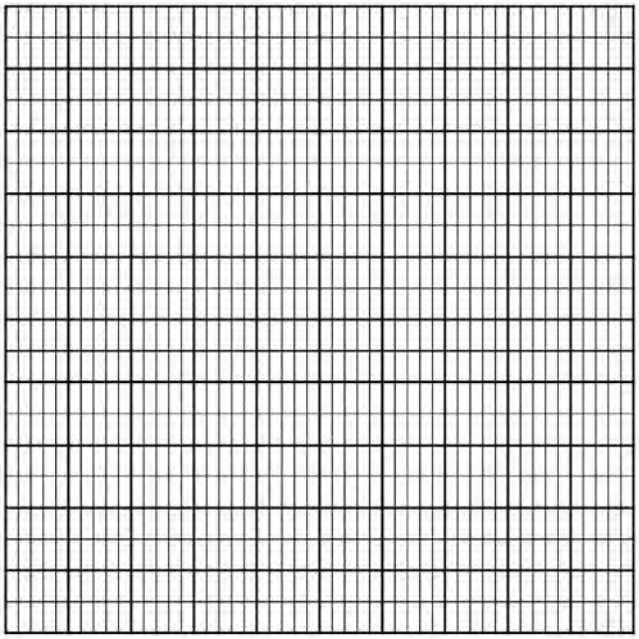

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# Saguaro Germination Data Tables

Control Group (the group that was planted in exactly the same way as recommended)

| **Date**: | **Number** of seeds germinated: | **Fractional part** of seeds germinated: | **Fractional part** of seeds germinated using 100 as denominator: | **Decimal** of seeds germinated: | **Percent** of seeds germinated: |
|---|---|---|---|---|---|
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Experimental Group (the group that was exposed to your independent variable)

| **Date**: | **Number** of seeds germinated: | **Fractional part** of seeds germinated: | **Fractional part** of seeds germinated using 100 as denominator: | **Decimal** of seeds germinated: | **Percent** of seeds germinated: |
|---|---|---|---|---|---|
| | | | | | |
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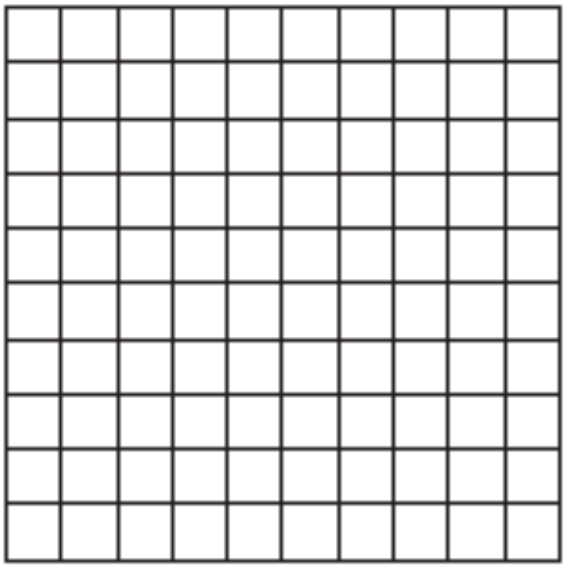
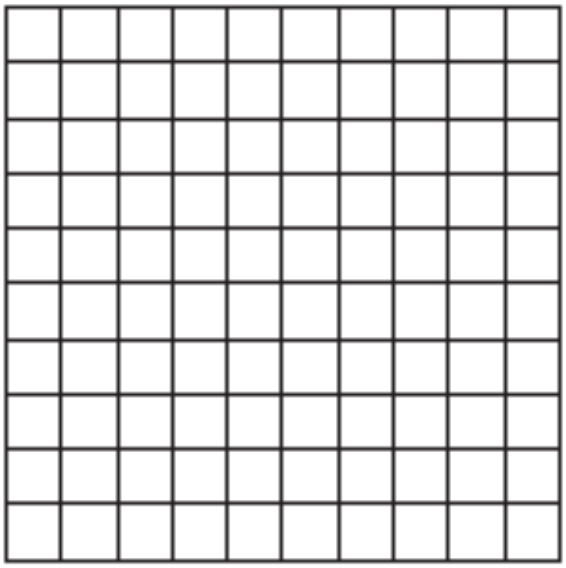
1. In the end did the experimental group or the control group have a higher rate of germination? Use the space below to demonstrate how you can tell which group of seeds was more successful. Use words, pictures, and numbers to explain.

2. Select another group to compare your experimental germination rates to.

I will compare my experimental group's germination rate to _____'s group.

| My group's germination rate: | _____'s group's germination rate: |
|---|---|
|  |  |
| Fraction: _____<br>Decimal: _____<br>Percent: _____ | Fraction: _____<br>Decimal: _____<br>Percent: _____ |

Compare the two germination rates: _____ ◯ _____

Use words, pictures, and numbers to explain which group's experiment had a higher germination rate:

| | | | | |
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The x-axis shows_____

The y-axis shows_____

List of ordered pairs:

Describe where the origin of a line graph is: _____

_____

Interpretations of my graph:

_____

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