* A **hypothesis** is a proposed explanation for a natural phenomenon. A **prediction** is a statement of what one expects to observe in a specific situation. A **null hypothesis** specifies what we should observe when the hypothesis being tested is wrong.
* There are several types of **variables**. Factors that are kept the same in experimental and control treatments—and which might affect the result—are called **controlled variables**. The variable that you manipulate—the one that differs between experimental and control groups—is the **independent** (or explanatory) variable. The independent variable is the factor that you think is driving change in a **dependent** (or response) variable.

1. You are given the data from Experiment #1 shown below. Each test group included 10 poppies of the same species, germinated in the same type of soil in a greenhouse. Plants were grown under controlled temperature conditions. The experiment was repeated three times with equivalent results.

**Experiment #1**

| Variable | Test Group 1 | Test Group 2 | Test Group 3 | Test Group 4 |
| --- | --- | --- | --- | --- |
| Water | 10 ml | 10 ml | 5 ml | 5 ml |
| Sunlight | 8 hours | 12 hours | 8 hours | 16 hours |
| Fertilizer | 10 grams | 20 grams | 20 grams | 20 grams |

Results of Experiment:

| Average growth of poppies per day | 0.5 cm | 1 cm | 1 cm | 1 cm |
| --- | --- | --- | --- | --- |

* How many poppies were included in each test group in Experiment #1? \_\_*\_\_\_\_10\_\_\_\_*\_\_\_\_\_\_\_ (this is **the sample size**)
* Why is sample size important? *Sample size is important because a smaller sample size can skew results based on the samples, making the results inaccurate. It is important to have as large of a sample size as possible, for the most accurate results.*
* What variable was being measured in Experiment #1? \_\_\_\_\_\_*\_Average growth of poppies per day\_\_\_\_\_*\_\_\_\_\_\_\_\_\_
* How was this variable measured? \_\_\_\_\_\_\_\_\_\_\_\_*\_Centimeters\_\_\_\_\_\_\_*\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* How many times was the experiment repeated? \_\_3\_\_\_\_\_\_\_\_
* Why do you think the experiment was repeated?  *The experiment was repeated to make sure that there were no errors in conducting the experiment the first or second time; that is, say, if an incorrect measurement of water or fertilizer was used, skewing the results.*
* Aside from the variables listed in the table, what additional variables were controlled? *Soil, location, temperature*
* Why was it important to control these other variables? *It was important to control these other variables in order to make sure that the results of the experiment were only affected by the manipulated variables -- water, sunlight, and fertilizer.*
* Can Experiment #1 be used to test the statement “the amount of sunlight poppies are exposed to influences their growth rate”? (circle one) YES NO

| **If YES**,  1) State which test groups should be compared to test this statement : Test group # \_\_3\_\_\_ and Test group # \_\_\_4\_\_  2) For the test groups you compared, list the following:  Independent variable: \_\_\_\_\_\_*\_Sunlight\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*\_\_\_\_  Dependent variable: \_\_\_\_\_*\_\_\_\_\_Average Growth of Poppies Per Day\_\_\_\_\_\_\_\_\_*\_\_\_\_\_\_\_\_\_\_\_\_  3) Explain whether the results support or refute the statement and why  *The results do not support the statement, since the growth of the poppy stays the same even with differing amounts of sunlight.* | **If NO**, explain why not, and describe the experiment you would need to perform in order to test this statement. |
| --- | --- |

* Are there any other conclusions about poppies that can be made based on the data shown in the table? Explain.

*I can conclude that fertilizer has a large effect on the growth of the poppies. As seen in the table, the amount of fertilizer is the only variable that correlates with the growth of the plant, with a direct ratio of 20:1. Even though less sunlight and water are used, the growth of the plant stays the same with the same amount of fertilizer in trials #2, #3, and #4.*

2. You are given the data from Experiment #2 shown below. Each test group included 10 poppies of the same species, germinated in the same type of soil in a greenhouse. Plants were grown under controlled temperature conditions. The experiment was repeated three times with equivalent results.

**Experiment #2**

| Variable | Test Group 1 | Test Group 2 | Test Group 3 |
| --- | --- | --- | --- |
| Water | 5 ml | 5 ml | 10 ml |
| Sunlight | 8h | 16h | 16h |
| Fertilizer | 10 grams | 20 grams | 10 grams |

Results of Experiment:

| Average growth of poppies per day | 0.5 cm | 1 cm | 1 cm |
| --- | --- | --- | --- |

Can Experiment #2 be used to test the statement “the amount of sunlight poppies are exposed to influences their growth rate”? (Circle one) YES NO

| **If YES**,  1) State which test groups should be compared to test this statement : Test Group # \_\_\_\_\_ and Test Group # \_\_\_\_\_  2) For the test groups you compared, list the following:  Independent variable: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*\_\_*\_\_\_\_  Dependent variable: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  3) Explain whether the results support or refute the statement and why | **If NO**, explain why not, and describe the experiment you would need to perform in order to test this statement.  *This experiment cannot be used to test the statement “the amount of sunlight poppies are exposed to influences their growth rate” since the experiment changes variables other than sunlight -- that is, the amount of fertilizer and water used to grow the plants. If one would like to actually test the statement, they could conduct the same experiment, but only change the amount of sunlight, keeping the amount of water and fertilizer used to grow the plants the same.* |
| --- | --- |

* Are there any other conclusions that can be made based on the data shown? Explain.

*In this experiment, it appears that sunlight has the largest effect on the growth of the poppies. The amount of sunlight is the only variable that directly correlates with the growth of the poppies, with a 16:1 ratio. Even though varying amounts of water and fertilizer are used, the growth of the poppies stays the same for trials #2 and #3.*

3) Write down the five steps of the scientific method in order and explain why these steps should be linked as a circle rather than as a straight line.

1. *Observation*
2. *Hypothesis*
3. *Experimentation*
4. *Publication*
5. *Confirmation*

*These steps should be linked as a circle because many peer reviews directly lead to new questions about the experiment, prompting others to make observations and perform other experiments, restarting the scientific method. However, if one makes the scientific method linear, the method stops at confirmation, prohibiting any sort of other theories or breakthroughs to be built on top of the results of the previous experiment.*

4) After reviewing the recording on Facts, Hypotheses, Scientific Laws and Scientific Theories, explain how to distinguish each of these terms from each other.

**FACT:** *An observation that is accepted as true.*

**HYPOTHESIS:** *A testable explanation for an observation.*

**SCIENTIFIC LAW:** *A description of a natural phenomenon; describes how it works, but not why.*

**SCIENTIFIC THEORY**: *An explanation of a natural phenomenon that is corroborated by many facts, hypotheses, and laws.*

5) Explain why a hypothesis can never be proven.

6) If a hypothesis is tested a number of times and supported each time, the best term to describe the “correctness” of that hypothesis is\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*retained*\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

7) If a hypothesis is tested and found to be incorrect, then we say that the hypothesis has been \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*rejected*\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .