INSTRUCTIONS: It is time to create your graphs of your data and write the results, and discussion/conclusions.

Instructions for how to write these sections can be found in your Student Handbook for Writing in Biology. Make sure to read the sections associated with writing the results and discussion sections BEFORE you begin to write. (https://knisely5e.sinauer.com)

**Please note that there are NO POINTS associated with discussing "errors." If you completely undermine the validity of the experiment by focusing on "errors" you will not be able to do the parts of the assignment for which you do get points. The point of the discussion is to explain our results and put them into the context of a larger body of scientific work. Therefore, you MUST cites sources; revisit the primary sources you included in the intro.

A rubric has been provided to help you in your preparation of your results and discussion. As always it is vital that all of your work be in your own words and that you make sure to spell and grammar check your work before submitting it.
It is important to review the rubric and the accepted file formats before you submit your paper.

Results and DIscussion

Criteria	Ratings					Pts
Content: Results	**25 pts** **Full Marks** Provides a clear and concise summary of the results, referring to the figures and tables	**20 pts** **Good** Provides a thorough, but not concise, summary of the results	**15 pts** **Fair, but needs work** Lists some extraneous information and raw data without summarizing results	**10 pts** **Needs Work** Does not summarize results, only references tables and figures		25 pts
Content: Figure	**10 pts** **Full Marks** Figure is properly formatted and displays all relevant information	**8 pts** **Good** Figure displays all relevant information but is not properly formatted	**6 pts** **Fair, but needs work** Figure displays relevant information, but with mistakes in data, and is not properly formatted	**4 pts** **Needs Work** Figure does not display relevant information and is not properly formatted	**0 pts** **No Marks**	10 pts
Content: Discussion	**30 pts** **Full Marks** The results are put into context (i.e., what do the results mean?) and tied to what other researchers have found	**24 pts** **Good** The results are somewhat put into context and loosely tied to what other researchers have found	**18 pts** **Fair, but needs work** The results are somewhat put into context, but there is no attempt to connect the results to other studies	**9 pts** **Needs Work** The results are poorly addressed and there is no attempt to connect the results to other studies	**0 pts** **No Marks**	30 pts
In-text citations and literature cited	**15 pts** **Full Marks** Literature is cited appropriately and correctly, citations are primary sources and relate to the research	**12 pts** **Good** A few errors in works cited, citations are primary sources	**6 pts** **Needs work** Numerous Errors in citation format, citations are not primary source	**0 pts** **No Marks** No citations		15 pts
Grammar	**10 pts** **Full Marks** Very well-written with no notable errors in usage and punctuation	**8 pts** **Good** Well-written with a few errors in usage and punctuation	**6 pts** **Fair, but needs work** Some usage and punctuation errors, errors detract from readability	**4 pts** **Needs Revision** Frequent usage and punctuation errors		10 pts
Concise writing	**10 pts** **Full Marks** Writing is concise and to the point with no extra flowery language	**7 pts** **Good** Overall context is concise, but word usage could be more scientific	**3 pts** **Needs Work** Writing is overly verbose and unacceptable for scientific writing	**0 pts** **No Marks**		10 pts
						Total Points: 100

100% View only

A1

	A	B	C	D	E	F	G	H	I	J	K
1		# seeds germinated at day 7									
2		CONTROL	TREATMENT		**I did the t-test for you guys so you can use the p-value in your results**						
3		9	10								
4		9	0								
5		9	9		**You guys have to make the two bar graphs based on the control and treatment group averages**						
6		8	8		**Treatment refers to the 0.2 M NaCl, Control is deionized water**						
7		10	9								
8		10	10		**Let me know if you have questions**						
9		10	9								
10		9	9								
11		10	8								
12		10	7								
13		10	10								
14		10	10								
15		10	6								
16		10	9								
17		9	8								
18		10	10								
19											
20											
21	Average	9.5625	8.25								
22											
23	p-value is .049797. The result is significant at p < .05.				**Some questions to think about when looking at p-value**						
24					**1. Do I use the null or alternative hypothesis?**						
25					**2. Now that I know there is no significant difference between the two groups, what does that mean for my results?**						
26											
27											
28											
29											

Sorghum

Results Section

- This section does not include explanation or interpretation of results.
  - You are just stating the raw quantitative data
  - Any analysis/conclusions need to go into the Discussion section
- Make sure to put graphs here and cite the figures in text

Figures and Tables

- Used to present information in a way that may be easier to understand than with just words
- Tables – think: Excel spreadsheet – any way of displaying data with words and/or numbers using rows and columns
    - However, raw data is not presented to the reader
- Figures - graphical representation of data

Discussion (seperate from results)

- This section interprets results, and contextualizes the results with literature
    - Begin discussion section with some sentences reminding the reader of the **objective** and **hypothesis** of the experiment, and main conclusion from results.
    - It is also useful to address the results in the context of your initial hypothesis given in the intro. It would be good to explicitly mention the hypothesis.
- Interpret the results
    - Why do we see the results/patterns that we see? Build on observations made in the Results section and connect to concepts in the introduction
- Connect results with the literature - compare AND contrast our results to results of other studies within the literature - these are great places to use your **two primary sources**

Discussion

- Discuss pitfalls of the experiment
    - Why might our data be biased?
    - Why might we need to replicate our experiment?
    - What should be changed for the next experiment?
    - What additional information would we need to draw more detailed conclusions about the effect of salt solutions and osmosis on seed germination?
- So what?
    - Why is it important that we study the topics of this experiment?
    - What are some applications of the knowledge we gained from this experiment?

Discussion

- Keep in mind:
  - Your discussion section is *supposed* to be thorough
  - Your discussion section doesn't have to answer every question in the previous slide, but it should cover all the big bullets

Discussion (in a nutshell)

- Results interpreted
- Hypothesis restated + was it supported or negated by the data
- Results related to published work (2 primary sources)
- Implications of results
- What did you expect to find? (predictions/hypothesis)
- And why? (citing previous studies)
- How do your results compare to what you expected?
- How might you explain Unexpected results?
- How could you test your explanation for this?

Hypotheses (should be similar to these)

Null hypothesis (H_0): When [seed type] seeds are grown in 0.2 M NaCl solution, there is *no significant difference* in the average germination after 7 days compared to the average germination of seeds grown in deionized water.

Alternative hypothesis (H_a): When [seed type] seeds are grown in 0.2 M NaCl solution, the average germination after 7 days will be *[greater than/less than]* the average germination of seeds grown in deionized water.

P-value

- I did the t-test to get p-value already for your data, so you can just state the p-value in the results and use it to argue why the null or alternative hypothesis is supported (remember, "if the P is low, reject that Ho")
- P-value > 0.05 means results are not significant, so **null hypothesis** is supported
- P-value < 0.05 means results are significant, so null hypothesis is rejected and **alternative hypothesis** is supported

References Page

- You need to put in-text citations from primary literature
- Include Reference section at the end of document

Results

- 2 paragraphs
- 1 bar graph showing total germination from day 7 of each group (Control and Experimental of each seed)

Discussion

- At least one page
- Interpret results
  - Restate null and alternative hypotheses
  - Results support/negate hypothesis
- How do these results compare to other studies (primary sources)?
- What can we do with all this information?

Methods, Materials, and 2 Primary Sources

Methods and Materials:

In this experiment, two paper towels were placed into two zippered bags. One zippered bag was labeled “experiment control” and the other was labeled “control”. 20 Sorghum seeds were given. 10 seeds were placed into the “control” zippered bag and the 10 seeds were placed into the “treatment” zippered bag. 10 mL of the 0.2M Sodium Chloride solution was added to the bag labeled “treatment.” 10 mL of water was added to the bag labeled “control.” Each bag was to be placed at a window for a light source. For seven days, the germination was observed and recorded. The control group in this experiment is the bag with 10 Sorghum seeds and water. The experimental group in this experiment is the bag with 10 Sorghum seeds and 0.2M Sodium Chloride solution.

Key Phrases:

- Germination
- Seed
- Experiment
- Embryo
- Stem

Primary Source Article List:

❖ CSE Citation (Article 1)
Casal JJ, Sanchez RA. 1998. Phytochromes and Seed Germination. Seed Science Research. 8(3): 317-329.

➢ Summary (Article 1)
Phytochrome is a photoreceptor used by plants to detect light sources. In other words. It’s a pigment used to manage a plant's development. Essentially it aids the plant with it’s seed germination process, as well as reproduction. Phytochrome is a small group of the photoreceptor family. Phytochrome B and Phytochrome A are distinct from one another. Aside from those two genes, there are others. Phytochrome A is most likely to be the gene involved when there is a high amount of radiant energy. Phytochrome B is involved in dark, dry seeds which

a small group of the photoreceptor family. Phytochrome B and Phytochrome A are distinct from one another. Aside from those two genes, there are others. Phytochrome A is most likely to be the gene involved when there is a high amount of radiant energy. Phytochrome B is involved in dark, dry seeds which eventually affects the plants process of growth and germination. Red light can come from direct sunlight which will have a great effect on the seed. Far red light correlates with darkness but also has an effect on germination. The embryo growth acts on the phytochrome and its role. Phytochrome research is slowly gaining more knowledge due to data collected based off of observations.

- CSE Citation (Article 2)

  Vazquez- Ramos JM, Sanchez MD. 2003. The Cell Cycle and Seed Germination. Seed Science Research. 13(2): 113-130.

  - Summary (Article 2)

    The cell cycle is a series of development steps in order to reach the creation of two daughter cells within an organism. The participation of genes in the cell cycle can vary from hundreds to thousands. The protein types stay the same among animal and plant cells, as well as the same pathways. Seed germination is essentially a very great way to study plants due to the delicate process of growth and development it allows an individual to observe. The G(1) checkpoint control guides many processes like the initiation of the germination process. G(1) and G(2) cell proteins appear to activate during specific times of the process, essentially meaning there's some sort of regulation happening within the organism. Regulation is necessary to keep an organism up to date with what needs to get done to keep it healthy and strong. The cell cycle's importance towards germination is enormous.