



Bioinformatics Bite #4: Intro to Experimental Design

Worksheet
Student Materials

OVERVIEW

This worksheet is part of a set of short lessons to help students become familiar with the basics of experimental design.

KEY CONCEPTS

- Independent variables are defined by the researcher's choice based on factors of interest when designing an experiment.
- Dependent variables are measured in response to the experiment.
- Control variables are held constant in all groups within an experiment.

OBJECTIVES

- Students will be able to define and identify a control variable.
- Students will be able to differentiate between an independent and a dependent variable.
- Students will be able to locate information related to variables in the GeneLab Data Repository

Bioinformatics Bite #4: Intro to experimental design

Part 1: Why is a control important in experimental design?

If you are conducting an experiment, how many factors should you be changing at once?

Why is it important to do this?

Imagine you were interested in whether sunlight was an important factor in plant growth. Think about the design parameters for this experiment. Describe an experiment that could help you test this idea. What would you have to change? What would you have to keep the same? How many different groups would you need to show an effect?

Since you are trying to show that sunlight has an effect on plant growth (perhaps you believe this is a positive effect and is needed to make plants grow, or perhaps you believe this is a negative effect and prevents plants from growing), anything you change between the group you are trying to study and the group you are trying to use to compare the study group to may be the cause of the change you are seeing in your results.

The group that receives no treatment to establish a background condition is called the control group.

The group(s) that involves a treatment or change in factor is/are called the experimental group(s).

What is your control group? _____

What is your experimental group? _____

What factor did you vary? _____

What factors did you control? _____

Part 2: What exactly are dependent variables depending on?

Imagine your class has a 10 gallon aquarium and you have 10 minnows in the tank which you have been raising since September. You have fed them the same food all year, but one of your classmates suggested a change in food would help the fish grow larger.

What is a possible hypothesis that your classmate is suggesting? _____

What do you need to change to be able to gather evidence to support or refute this hypothesis?

This is your independent variable. You know that you will change it in order to see a different outcome in the experiment. You also know how you will change it. Since these changes do not depend on you carrying out the experiment, you can consider them to be independent of the experiment.

What is it that you will measure or collect to be able to substantiate or refute your hypothesis?

This will be a measure of the dependent variable. You can not predict with certainty how much this factor will change, that depends on you conducting the experiment.

What do you need to be able to keep consistent in the experiment while gathering evidence to be able to say with certainty that the changes you observed came from the factor you changed?

These are controlled variables. If they are not the same for each experimental group, you are introducing additional variables to the experiment and your results are no longer based on changing just one variable. This makes it impossible to state which variable caused the change you observed.

Part 3: What does this look like in the GeneLab Data Repository?

Navigate to <https://genelab.nasa.gov/>. Select the Data & Tools tab and select Data Repository from the drop down menu (Figure 1).

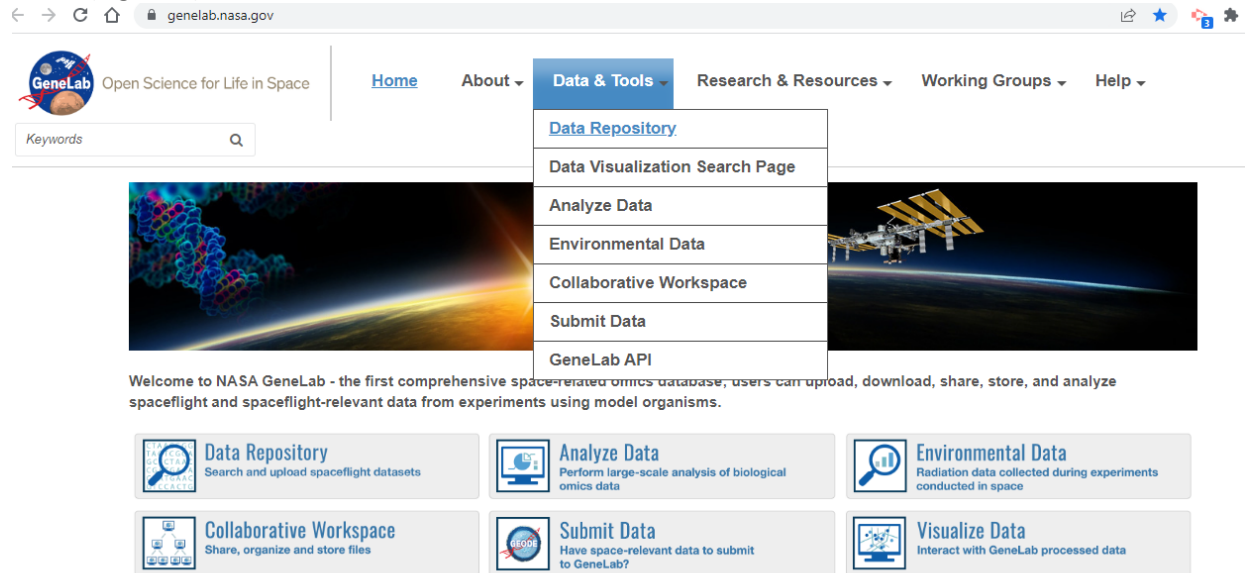


Figure 1. GeneLab website homepage

In the search box at Data Repository, type in “GLDS-213” and select the resulting file. Let’s take a moment to see what information is here (Figure 2) .

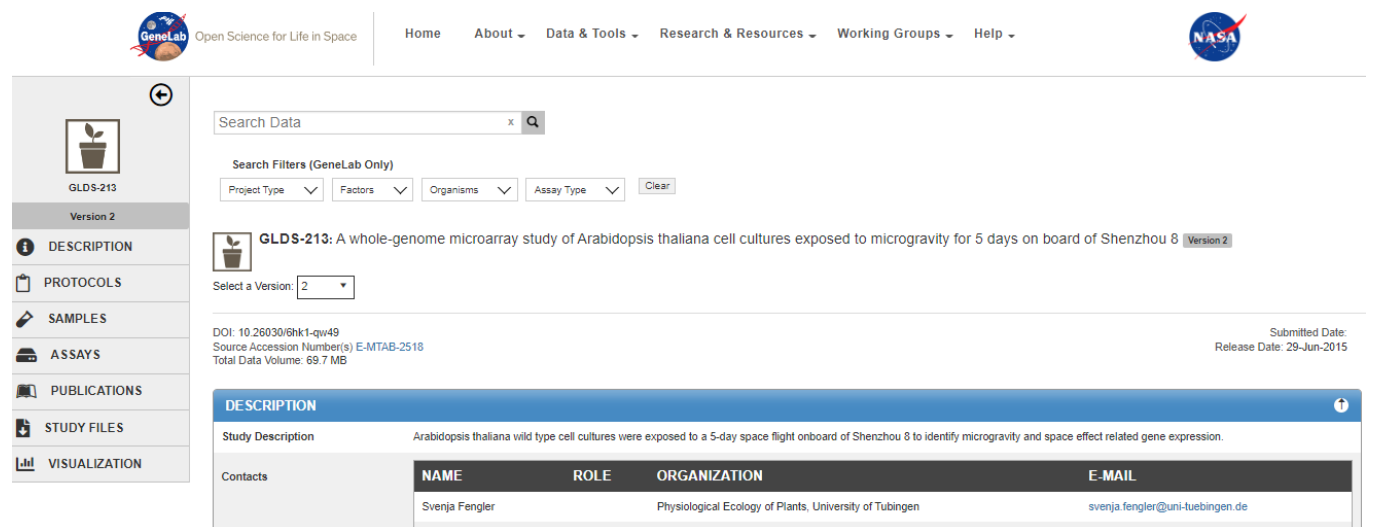


Figure 2. GLDS-213 Study page

- **Description:** Details the plan of the study conducted and often contains abstract information. This is particularly useful in trying to understand the premise of the research conducted.
- **Protocols:** Explains the particular methods used for the study.
- **Samples:** Lists the samples involved in the study and information about each sample.
- **Assays:** Details specific tests that are run on the samples.
- **Publications:** Has direct links to published, open source studies from the research.
- **Study files:** Typically contain data files with more information about the data and findings.

- *Visualization*: Will show a range of different plots that you may learn about in other Biotechnology Bites (not prepared for each study).

To better understand what this research is about, two sections are particularly beneficial and we will look at them first: *Description* and *Publications*. For this study, the description is brief, so looking into the publication is necessary, but this is not always the case. Select the description and read the information on the study. Then navigate to the *Publications* tab and open the publication to read the abstract.

Summarize what the researchers are looking into: _____

What is the factor(s) that they are investigating and how do you know? _____

What is the independent variable? _____

What is the dependent variable? _____

What are the controlled variables? _____

Part 4: Examining the Data Repository independently

Select a dataset of your own from the Data Repository. You may browse by model organism, search for a particular feature you may be interested in or use any other criteria to select a dataset.

Dataset number : _____

Dataset title: _____

You will now follow the same process you used in part 3 with your class to review your individual dataset. Feel free to look beyond the description and publication sections. The sample list is often helpful in discerning what the researchers are looking for.

Summarize what the researchers are looking into: _____

Note: Sometimes spaceflight will test spaceflight vs ground control as one factor, then test a separate factor in spaceflight. When this is the case, you will have more than one factor as an independent variable - but you will only look at one at a time. For instance, in part 3, the researchers compared ground control to 1g spaceflight (gravity controlled, spaceflight varied) then compared 1g spaceflight to microgravity spaceflight (spaceflight controlled, gravity varied).

What is the factor(s) that they are investigating and how do you know? _____

What is the independent variable? (If multiple factors are examined, explain how)

What is the dependent variable? (If multiple factors are examined, explain how)

What are the controlled variables? (If multiple factors are examined, explain how)

Switch papers with another student and go through their part 4 answers. If after reviewing their data set, you agree with them, you are ready to review this material with the teacher.

Part 5: Learning Aims and Evaluation

Please rate where you personally are at, with regards to the learning aims, at the end of the lesson and why.

Rating Scale

- 1- I do not understand it at all yet.
- 2- I understand parts of it, but I need my teacher and/or classmates' support to answer questions.
- 3- I understand it and can complete an assignment by myself.
- 4- I understand it so well I can teach others and apply my knowledge to new situations.

Learning Aim #1: Students will be able to define and identify a control variable.

My Evaluation of Learning Aim #1 and Explanation:

Learning Aim #2: Students will be able to differentiate between an independent and a dependent variable.

My Evaluation of Learning Aim #2 and Explanation:

Learning Aim #3: Students will be able to locate information related to variables in the GeneLab Data Repository.

My Evaluation of Learning Aim #3 and Explanation:

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