Lab 1: Introduction to Scientific Method and Scientific Literature

Purpose: The purpose of this activity is for you to evaluate experimental design while learning how to read and interpret a scientific article.

This lab will help you practice the following **skills**:

1. Identifying the key components of scientific experiments
2. Implementation of the scientific method
3. Interpreting experimental data in a scientific paper
4. Using KSU library resources to find academic research articles.

This assignment will help you gain the following **knowledge**:

1. Understanding how scientific experiments are designed
2. Distinguishing the components of scientific data and its application
3. Differentiating between the scientific method and experimental design
4. Differentiating between primary and secondary scientific literature

In this course, you will conduct several experiments and learn how to use scientific equipment to explore cells and the molecular biology in plants and animals, as well as the biochemistry of life.

For you to do this you must first learn about experimental design and how to generate and interpret scientific data.

I. Scientific Experiments

A **Scientific Experiment** is any process in which measurements are used and tests are carried out to verify or prove false a hypothesis. An experiment is designed in such a way that scientists can make a discovery of something unknown or find a correlation in something already known. The goal is to increase the data we know about a certain concept in nature. A scientific experiment relies on several key components.

Components of scientific experiments

- A **hypothesis** is a proposition that appears to be true, but has not yet been confirmed, and from which an investigation can be developed. It is an explanation based on observations and assumptions that leads to a testable prediction.

  Here is an example of a well-written hypothesis, “Vaccines help reduce the spread of a virus.” Please note, that a hypothesis cannot be written as an “if-and-then” statement because then it would be considered a prediction. Please read the information below to learn more about predictions.

- A **prediction** is related to a hypothesis but is specific to an experiment. When writing a prediction, think of what you would expect your results to be. A prediction must be written as an "if-and-then" statement.

  Here is an example of a prediction statement, "If people receive a vaccine, then they will contract the virus less often."

- A **controlled experiment** compares an experimental group, for example, people who receive a vaccine with a control group, which does not receive a vaccine but rather a placebo. The control group can help you determine if the factor that is being tested has an effect.
- The **independent variable** of an experiment is the experimental factor manipulated by the researcher. For an experiment designed to test if vaccines reduce the spread of a virus, the dosage of the vaccine given to the experimental group is considered the independent variable.
- A **dependent variable** of an experiment (there may be more than one) is an observed or measured effect of the manipulated factor (the independent variable). Concerning the vaccine experiment example, the researchers may measure the number of individuals who contract the virus. The transmission rate (dependent variable) is dependent on the vaccine (independent variable). Please remember, the dependent variable *depends on* the independent variable.

Here is a simple way to help you memorize and recognize the variables on a graph.

DRY MIX

D = dependent variable being tested

R = responding variable

Y = graph information on the vertical or y-axis

M = manipulated variable

I = independent variable the one you change or control

X = graph information on the horizontal or x-axis

Collecting Data and Graphing

In an experiment, you measure variables and then record and analyze the data, usually in tables and graphs. The standard way to collect data in a table is seen below. Figure 1 is quantitative data and Fig. 2 is qualitative data.

Fig.1 Number of Dead Brine Shrimp Over Time

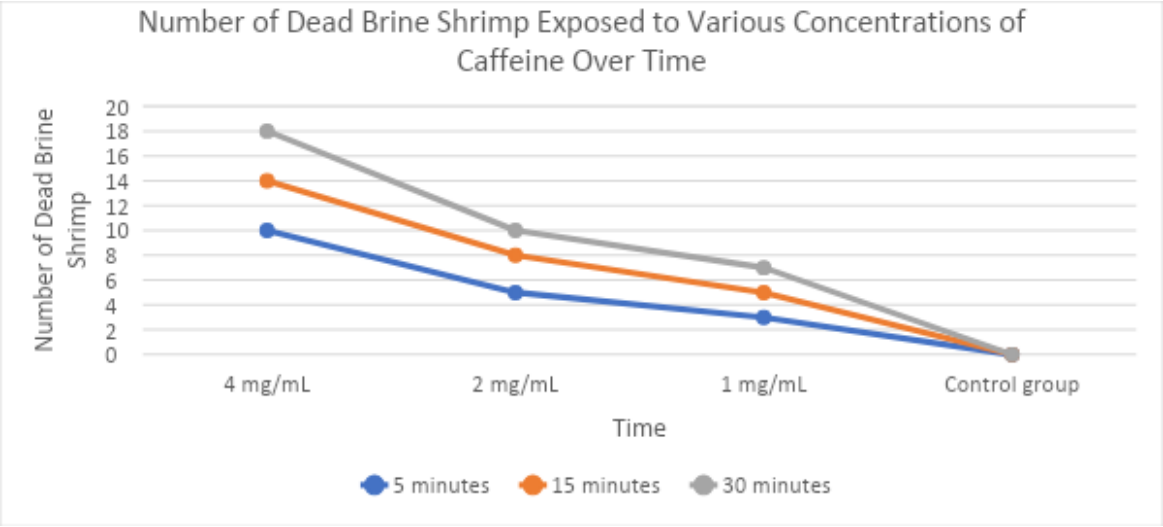
Caffeine Concentration	Number of Dead Brine Shrimp Over Time		
	5 minutes	15 minutes	30 minutes
4 mg/mL	10	14	18
2 mg/mL	5	8	10
1 mg/mL	3	5	7
Control group	0	0	0

Fig. 2 Observations of Brine Shrimp Movement in Various Concentrations of Caffeine over Time

Caffeine Concentration	Observations of brine shrimp over time		
	0 minutes	15 minutes	30 minutes
4 mg/mL	Adults moving erratically with no clear direction or pattern, lots of cysts distributed randomly throughout	Adults still active and moving erratically, quickly, and in random directions/zigzags, stagger-like movement, no change in cysts	A few adults dead, most alive and no change in movement, no change in cysts
2 mg/mL	Adults moving erratically with no clear direction or pattern, lots of cysts distributed randomly throughout	Adults still active and moving erratically, many moving in large circles, no change in cysts	No change
1 mg/mL	Adults moving erratically with no clear direction or pattern, lots of cysts distributed randomly throughout	Adults still active and moving erratically, some moving in small circles, no change in cysts throughout	No change
Control group	Adults moving erratically with no clear direction or pattern, lots of cysts distributed randomly throughout	No change	No change

You can create a graph with your data, which can help you with the independent variable on the x-axis and the dependent variable on the y-axis. Graphs are a visual display of information and show the overall shape of your results rather than the details. They can help you understand large amounts of data and spot patterns, trends, exceptions, or outliers. See Fig. 3

Fig. 3 Number of Dead Brine Shrimp Exposed to Various Concentrations of Caffeine Over Time



Experiments allow you to collect and analyze data that is important to describing your results and forming your conclusions. There are 2 types of data.

Types of data

- **Qualitative data** – data that are descriptions rather than measurements. For example, what you are looking at under a microscope. Qualitative data can include observed color, smell, taste, touch or feeling, typology, and shapes. This type of data is often displayed in tables (not graphs).

- **Quantitative data** – data that are recorded as measurements. Qualitative data can include age, weight, height, length, population, size, and other numerical values. These are sometimes organized into tables and graphs.

Now we will review the scientific method that you will use to create and perform a scientific experiment!

The Scientific Method

Even though it is called the scientific method, this method is not only used in scientific experiments. You use the scientific method often in your daily life without even realizing it.

In general, the scientific method involves 6 steps.

1. Ask a question
2. Do background research
3. Construct a hypothesis
4. Conduct experiments to test a hypothesis
5. Analyze data
6. Draw conclusions

Note that the scientific method is not always a linear process. Sometimes after completing all the steps in the scientific method, a scientist must go back and do more background research to refine their hypothesis. Watch this video: https://youtu.be/Xxm_beTs2LU?si=ZUQ1sMBhwCuZrd4E

Let's Practice:

You will complete this as a group at your table. **Do NOT answer these questions before lab.**

Question: It is the start of the semester, and you realize that you only have 10 minutes between classes and cannot be late. You need a plan! You need to determine the fastest route to get to your biology lab from your biology class, which is on the other side of campus.

Using the scientific method process, determine the fastest route to class, by filling out the information below. You and your group have 10 minutes to complete this task.

Q1. What background information do you need to research?

A map, starting location, ending locations, modes of transportation, obstacles (stairs, elevators, etc).

Q2. What is your hypothesis?

The fastest route is the shortest route

Q3. What is your prediction (make sure it is written as an if, then statement and includes your independent and dependent variables)?

If you take the shortest route, then it will take less time

(Independent : distance, Dependent : time)

Q4. How will you test your hypothesis and prediction?

Try different routes

Q5. What type of data will you collect?

Record time and distance

Q6. Is this data qualitative, quantitative, or both?

Quantitative

Q7. You analyze your data and find out that it will take you 12 minutes to get to your biology lab. What do you do next?

Leave prior class earlier, notify instructor, or find alternative transportation

II. Scientific Literature

There are two types of scientific literature: Primary and Secondary.

Primary scientific literature has the following key characteristics:

- A journal article describing hypotheses, methodology, experimental design, data, results, and conclusions.
- First (primary) publication of the researcher's experiments and findings.
- Written by researcher.
- Always contains intext citations and a Literature Cited/References section
- Examples of scholarly journals that publish primary literature in Biology: PLOS Biology, Science, Nature, Animal Behaviour, Journal of Cell Biology, Journal of Neuroscience, etc.

Secondary scientific literature has the following key characteristics:

- Are reviews of multiple research publications
- They are summarized by someone other than the researcher
- Examples are scientific news articles, textbooks, encyclopedias, and other reference-type materials that provide fact-checked background information on a subject.

Outline of primary literature:

In preparing to read a research article, *think about settling down to read the details of a juicy news story published in your favorite (Biology) magazine.* Primary research articles generally have 6 parts: 1) Abstract, 2) Introduction, 3) Materials and Methods, 4) Results, 5) Discussion, and 6) References. The purpose of each of these sections is described on the next page. When reading a research article, you will come across new terminology and methodology. It is always a clever idea to underline or highlight the parts you are unfamiliar with and go to the web to find out more.

What is a Peer-Reviewed Article?

Peer review describes the process that an article goes through before it can be published in a scholarly/academic journal. Peer-reviewed articles are often called Academic, Scholarly, or Refereed.

1. An academic or expert writes an article whose intended audience is other academics, experts, or students.
2. The article is then submitted for review to the editors of an academic journal.
    a. Example: Editors of Social Science Quarterly
3. Editors review the article.
    a. Options: Acceptance, Return with Suggestions, Reject
    b. Example: Social Science Quarterly accepts about 15% of submissions.

Popular articles are another type of article. Unlike scholarly articles, popular articles typically are not written or reviewed by experts. They are written by professional writers or journalists for a general audience. They are usually published in magazines or newspapers.

For more information on what it means to be "peer-reviewed," check out the Research 101 Guide (https://libguides.kennesaw.edu/Library101) and watch the video on this website **https://libanswers.kennesaw.edu/ris/faq/198114**

Research articles are typically written according to some of the Scientific Method steps.

TABLE 1. Correlation of the Scientific Method and Scientific Literature

Parts of Scientific Method	Sections in primary scientific literature research articles
	ABSTRACT ▪ Summary of research article containing highlights of each section of the paper. ▪ Typically read first to get an overall idea of what the paper is about.
1. Ask a question 2. Do background research 3. Construct a hypothesis	**INTRODUCTION** ▪ Describes the observations and rationale that lead to the question of interest. ▪ Includes background information surrounding the question or problem to be solved. These questions are often derived from conclusions of previous research. ▪ States a simple, testable hypothesis that describes the relationship between variables to be manipulated and outcomes to be

TABLE 1. Correlation of the Scientific Method and Scientific Literature	
Parts of Scientific Method	**Sections in primary scientific literature research articles**
	measured. Can include one or more predictions that is specific to the experiment.
4. Conduct experiments to test the hypothesis	**MATERIALS & METHODS** ▪ Describes details of how experiments were conducted including all subjects, controls, reagents, and apparatuses used, as well as timelines and measurements e.g., volumes, temperatures, timelines.
5. Analyze data	**RESULTS** ▪ Reports results of each experiment using graphs, tables, images, and statistics. Before reading the report, examine the figures and read their captions first.
6. Draw a Conclusion	**DISCUSSION** ▪ Accepts or rejects hypothesis. ▪ Compares current work to the scientific context by comparing and/or contrasting current work with previously published work. ▪ Discusses the relevance of this conclusion to initial observations. ▪ May propose further questions to be addressed in future experiments.
7. References	**REFERENCES** ▪ List of scholarly sources that are cited in the article. ▪ Formatted in a specific way according to the journal's specifications.

III. Analyzing a primary research article:

Please read the brine shrimp article (found in D2L under the Worksheets tab, labeled as "Lab 1 Article Only - or by clicking on the link below:
https://kennesaw.view.usg.edu/d2l/le/content/2409965/viewContent/38418675/View

In the lab, you will work with your table to discuss the article and complete the questions below. **You must read through the article before lab to participate fully in the assignment. Do not answer the questions in this worksheet before lab. We will work on the answers together in the lab.**

The instructor will call upon each group randomly to share their answers to a question, allowing all students to discuss and complete the full exercise.

Q1. Why do you think it's important for a research article to have an Abstract?

Gives a quick overview of the paper, but serves a different purpose than the introduction.

Q2. In your own words explain what you think this paper is about:

Brine shrimp survival in the waters of Lake Bunyampaka.

Q3. In the background information, list at least 2 research-supported information, justifying the use of *Artemia* in these experiments.

1) **"the brine shrimp Artemia sp. has proved to be very successful as a larval feed"**
2) **"Artemia can survive in hypersaline environments where none of its predators are capable of surviving"**

Q4. What are the hypotheses of the study?

Lake Bunyampaka is a suitable environment for the growth of brine shrimp.

Q5. What is the prediction, if any?

N/A

Q6. Describe the test subjects in this study.

Great Salt Lake Artemia strain from the United States and Vinh Chau Artemia strain from Vietnam.

Q8. Briefly describe the materials and methods used.

Ex 0: 2 different salinity values

Ex 1: 2 different Artemia strains in 3 different salinities; GSL vs VC, 30 vs 35 vs 50 salinity, and the goal was determine survivability

Ex 2: VC strain at 30 g/L salinity over 20 days to determine growth

Ex 3: VC strain at 30 g/L salinity to determine ability to reproduce

Q9. Briefly describe the results and discussion.

There were several influencing factors, but the Brine shrimp survived best at 30 g/L salinity.

Q10. Describe the data collected in the table.

Lists the differences in salinity, age at first offspring, brood size, inter-brood interval, number of offspring, total offspring production, and percentage of offspring produced as cysts for the Lake Bunyampaka water.

Q11. Describe the data represented in Figures/graphs 2a, 2b, and 3.

Data for survivability of the control group, GSL group, and VS group

- What does the x-axis represent in each graph?

  Time
- What is measured on the y-axis of each graph?

  Proportion of survived animals

Q12. What are the conclusions

Brine Shrimp can survive and reproduce in the Lake Bunyampaka water, but not as effectively as in their natural habitat.

Q13. Does this paper explain why this research is relevant?

- If yes, how do they do this?

  Yes, in the introduction they mention that the supply of fish is declining in Uganda, and they want to restore the population by introducing Brine Shrimp for the fish to feed on

- If not, what information would you need to convince you that this research is important?

Q14. The authors provide limitations of the study. What are two of these?

1) **Seasonal fluctuations**
2) **Using non-diluted water or water less diluted than in our experiments.**

Q15. Are references correctly cited?

Yes

IV. Finding Primary (Peer-Reviewed) Scientific Articles

Finding Peer-Reviewed Articles

1. You can find articles (in magazines, newspapers, scholarly or peer-reviewed journals) from the SuperSearch Tab on the library website. Here you can enter keywords that will search both our KSU library catalog (books, e-books, government documents, films, etc.) and many of the subscription databases all in one search engine.

2. Once you conduct your search you can limit the results to scholarly or peer-reviewed publications only. On your results list, there is a button you can check on the left side of the screen that reads "Scholarly (Peer-Reviewed) Journals." Clicking this option will limit the results to only peer-reviewed/scholarly journal articles.

3. Based on what you've learned about doing a literature search, answer the questions below:

Q1. With your group, decide on a topic you want to research using the library SuperSearch function. What topic did you choose?

Table Salt

Q2. Enter the topic in SuperSearch. How many articles came up in your search?

4,718,988

Q3. Take a look at the filters on the left side of your search results. What are two ways you can filter the results?

1. Peer Reviewed

2. Time since publication

Q4. Identify an article that is both peer-reviewed and published in the past year. Place the correctly cited source below.

Dimaongon, Noralyn G., et al. "Emerging Microplastic Contamination in the Food Industry: The Case of Commercial Table Salts in Iligan, Philippines." *Philippine Journal of Science*, vol. 153, no. 1, Feb. 2024, pp. 75–79. *EBSCOhost*, research.ebsco.com/linkprocessor/plink?id=27edeb8e-1a80-3979-882e-5867baafe25b.