Lab 1: Introduction to Scientific Measurement

BIOL-8

Name: ______________________ **Date:** ______________________

Objectives

By the end of this lab, you will be able to:

- **Familiarize yourself with the laboratory environment**, including available equipment, safety features, and resources for scientific investigation
- **Identify physical aspects** of objects that can be measured using appropriate scientific terminology
- **Select appropriate measurement devices and units** for different properties, demonstrating understanding of metric and SI systems
- **Make accurate measurements** and document your methodology with sufficient detail for reproducibility
- **Formulate scientific questions** based on careful observations, distinguishing between observations and inferences
- **Design measurement approaches** to investigate biological questions using variables and controls
- **Communicate scientific findings** and propose next steps using proper scientific conventions

---

Part 0: Lab Orientation

> ***Learning Goal:*** *Before we begin measuring objects, scientists must first understand their workspace. Knowing what tools are available—and how to use them safely—is essential for productive research.*

Take 5-10 minutes to explore the laboratory environment.

What measurement tools and equipment are available in this lab?

List at least 5 tools you find (e.g., rulers, balances, thermometers, microscopes, graduated cylinders):

Where are the following safety features located?

- [ ] Fire extinguisher
- [ ] Emergency eyewash station
- [ ] First aid kit
- [ ] Emergency exit
- [ ] Safety goggles/gloves storage

What is one thing that surprised you about this lab space?

Based on the equipment available, what types of measurements could we perform in this lab?

Part 1: Object Selection

> ***Learning Goal:*** *Practice selecting appropriate subjects for scientific study. Scientists must often decide between studying objects they can directly manipulate and those they can only observe from a distance. This distinction affects methodology significantly.*

Choose two objects to study throughout this lab—one that you can directly access and one that you cannot.

Object Selection

Object in room: _

Object NOT in room: _

Why did you choose these objects?

Consider: What makes them interesting to study? How are they connected to biology or human health?

Pro tip: Choose objects you find genuinely interesting! Object B could be something distant (the moon, a mountain), microscopic (a single cell, bacteria), or simply elsewhere (your car, a tree outside). Think about objects relevant to biology—living organisms, body parts, or items that interact with biological systems.

Part 2: Identifying Physical Aspects

> ***Learning Goal:*** *Develop the ability to systematically identify measurable properties and match them with appropriate tools and units. This skill is fundamental to the scientific method. Note the difference between qualitative observations (descriptive) and quantitative measurements (numerical).*

For each object, identify **5 different physical aspects** that could potentially be measured. Physical aspects are quantifiable properties such as length, mass, temperature, volume, surface area, color intensity, hardness, density, or biological metrics like heart rate or growth rate.

Object A (In Room)

Physical Aspects — Object A

#	Physical Aspect	Measurement Device	Measurement Unit
1			
2			
3			
4			
5			

Object B (NOT in Room)

Physical Aspects — Object B

#	Physical Aspect	Measurement Device	Measurement Unit
1			
2			
3			
4			
5			

Reflection: Qualitative vs. Quantitative

Which of the aspects you listed are truly *quantitative* (can be expressed as a number)? Which might be more *qualitative* (descriptive)? Why does this distinction matter in science?

Hint: Consider both physical properties (mass, length, temperature) and functional properties (speed, frequency, rate of change). For biological objects, think about physiological measurements too. The metric system (meters, grams, liters) is the international standard for scientific measurement.

Part 3: Evaluating Measurement Feasibility

> ***Learning Goal:*** *Understand the practical constraints of scientific measurement. Real research requires identifying resources, planning ahead, and sometimes finding creative alternatives. Constraints include time, equipment, access, ethics, and expertise.*

Not all measurements are equally accessible. Consider what you could measure *right now* versus what would require additional resources.

For Object A (In Room)

Which physical aspects could we measure tonight with available resources?

For aspects we cannot measure tonight, what would be required?

Check all that apply:

- [ ] Internet access (for reference data or remote sensing)
- [ ] Money or funding (to purchase equipment)
- [ ] Institutional review or permission (IRB for human subjects)
- [ ] Equipment from another location
- [ ] Specialized training or expertise

- [ ] More time (for longitudinal measurements)
- [ ] Other:

Explain your reasoning for one aspect that requires additional resources:

For Object B (NOT in Room)

What would be required to measure this object's physical aspects?

What additional challenges exist compared to Object A?

Check all that apply:

- [ ] Physical access to the object
- [ ] Transportation of measurement equipment
- [ ] Time constraints
- [ ] Cost considerations
- [ ] Safety concerns
- [ ] Ethical considerations (e.g., living organisms, human subjects)
- [ ] Other:

Explain the most significant challenge:

Part 4: Making Measurements

> ***Learning Goal:*** *Practice the actual act of measurement, including choosing methods, recording data systematically, and documenting your methodology clearly enough that others could replicate your work. Reproducibility is a cornerstone of science.*

Now make some actual measurements of **Object A**. You may use formal instruments, estimation, or comparisons—the key is to document what you did and why.

Describe what you measured and how you did it for Object A:

Include these elements for full credit:

- What aspects did you measure?
- What tools or methods did you use?
- What values did you obtain (with units)?
- What challenges did you encounter?
- How confident are you in your measurements? (high/medium/low and why)

For Object B, describe how you would obtain measurements (or explain why direct measurement is not possible):

What alternative approaches might work? Could you use indirect measurement, estimation, or reference data?

Part 5: Generating Questions from Observations

> ***Learning Goal:*** *Transition from pure measurement to scientific inquiry. The best scientists notice patterns, ask questions, and design experiments to answer them—this is the heart of the scientific method you learned about in Module 01. Remember: observations are facts you perceive; inferences are conclusions you draw from those facts.*

Having examined your objects, now look at them with fresh eyes. What do you notice? What makes you curious?

Object A

What did you observe about Object A? *(Write 2 observations—things you noticed while measuring or examining the object)*

1. ____________________
2. ____________________

What questions do you have about Object A? *(Write 2 questions that your observations raised)*

1. ____________________
2. ____________________

For one of your questions, what type of question is it?

- [ ] Descriptive (What is happening?)
- [ ] Comparative (How do things differ?)
- [ ] Causal (What causes this?)
- [ ] Mechanistic (How does this work?)

Object B

What did you observe about Object B? *(Write 2 observations)*

1.
2.

What questions do you have about Object B? *(Write 2 questions)*

1.
2.

Pro tip: Good scientific questions often start with "How does...?", "What causes...?", "Why does...?", or "What would happen if...?" These lead to testable hypotheses. Avoid questions that can be answered with "yes" or "no."

Part 6: Designing an Investigation

Learning Goal: *Connect questions to testable investigations by identifying relevant measurements, expected outcomes, and experimental conditions. This applies the scientific method framework from your Module 01 studies. A good experiment has a clear independent variable (what you manipulate) and dependent variable (what you measure).*

Select **one question** from Part 5 for each object and develop an investigation plan.

Investigation for Object A

Selected question:

What situations or conditions would help answer this question?
(Example: Different temperatures, times of day, locations, or states of the object)

Which measurements from your list would be most relevant?

What would be your hypothesis? *(Make a specific, testable prediction using "If... then..." format)*

What would be your independent variable (what you change) and dependent variable (what you measure)?

Independent variable:

Dependent variable:

What would you keep constant (controlled variables)?

Investigation for Object B

Selected question:

What situations or conditions would help answer this question?

Which measurements would be most relevant?

What would be your hypothesis? *(Use "If... then..." format)*

Part 7: Predicting and Representing Results

Learning Goal: *Practice scientific prediction and data visualization—essential skills for testing hypotheses and communicating findings. Scientists must anticipate results to design meaningful experiments. Different types of data require different visualization approaches.*

Choose one investigation from Part 6 and think through what results might look like.

What might typical results look like?
(Describe specific numbers, patterns, or trends you might observe)

How would you interpret different possible outcomes?

If results show...	This would suggest...
Higher values	
Lower values	
No pattern	
Unexpected pattern	

How would you visually represent this data?
(Describe or sketch: bar graph, line chart, scatter plot, table, diagram, etc. Explain why this format is appropriate for your data type.)

Part 8: Communicating Your Research

> ***Learning Goal:*** *Understand that scientific work is incomplete until it is shared. Scientists communicate findings through papers, presentations, and discussions—this is how knowledge advances. Clear communication allows others to build on your work and verify your findings.*

Science is a collaborative endeavor. Discoveries only advance knowledge when they are communicated clearly to others.

Why is it important to communicate scientific findings?

Consider: How does sharing results benefit other scientists? How does it benefit society? What happens when research is not shared? What role does peer review play?

Summarize what you learned from this investigation in 2-3 sentences, as if explaining to a classmate who wasn't in lab today:

What are the next steps you would take in this investigation, and why?

Consider: What follow-up questions emerged? What would you measure differently? What new conditions would you test? What equipment would help? How would you increase sample size or reduce error?

What limitations or uncertainties exist in your current findings?

Consider: measurement error, sample size, time constraints, equipment limitations, assumptions made.

Summary

In this lab, you practiced the complete arc of scientific measurement and inquiry:

Part	Skill	What You Learned
0	Lab Orientation	Familiarizing yourself with lab resources and safety
1	Object Selection	Choosing appropriate subjects for study
2	Physical Aspects	Identifying measurable properties
3	Feasibility	Evaluating practical constraints
4	Measurement	Collecting and documenting data
5	Observation	Generating questions from data
6	Investigation Design	Planning testable experiments
7	Prediction	Anticipating and representing results
8	Communication	Sharing findings and proposing next steps

Connection to Module 01: This lab directly applies the scientific method you learned about in "Exploring Life Science." You practiced making observations, distinguishing observations from inferences, forming hypotheses, identifying variables, controlling experiments, and communicating results—the same process used by scientists worldwide to understand the living world.

Key Takeaway: Scientific measurement is not just about collecting numbers—it begins with curiosity, requires careful planning, and culminates in communicating discoveries and identifying new questions to pursue. This cycle of inquiry drives all biological research, from molecular biology to ecology to human health.

Lab adapted for BIOL-8: Human Biology, Spring 2026