Scientific Method (Black Box Experiment)

Objectives

1. Understand and explain the process of the scientific method.
2. Generate, test and evaluate hypotheses using proper experimental design.

**Prior to this lab, you should read Section 1.5 (“Doing Biology”) in your textbook (Freeman, 4th ed).**

Introduction

The purpose of today’s lab is to introduce you to the process known as the scientific method. Scientists use the scientific method to answer questions and provide explanations about natural phenomena. It is a logical process based on careful observation and experimentation.

The scientific method begins with an observation that leads to a question about the observed phenomena. Based on observations scientists generate a hypothesis, or tentative explanation for the observed phenomena. Hypotheses are written as statements and they should always be testable. A good hypothesis offers only one explanation and leads to predictions (often written as an “if-then” statement). The predictions are tested using carefully designed experiments. If possible, experiments should only test one factor (variable) at a time, with all other conditions being kept constant. Data collected from the experiments are analyzed and evaluated in respect to the original hypothesis statement, and conclusions are drawn. If the experiment has been designed properly, the data should either support or reject the hypothesis. If you can neither support nor reject the hypothesis statement, then the experiment has been poorly designed.

The scientific method does not end here. If the experimental analysis leads to a rejection of the hypothesis, then a new or revised hypothesis statement is constructed and the process starts over. If the hypothesis is supported, further experimentation is still warranted. Repetition strengthens the evidence for hypotheses. It is important to remember that scientific inquiry is an ongoing process and hypotheses are never considered to be proven. New data may alter or even reject previously supported scientific explanations.

Procedure – The Black Box Experiment

Your task today is to use the scientific method to determine the contents of a “black box”. Scientific experiments can involve the use of both direct and indirect measurements, and you will use both types in today’s lab. Each lab group will be given a sealed box containing various items. Your instructor will provide you with a list of items that may be present in your box. Each group will also be provided with the following: a balance, an empty box of the same type as the sealed black box, and access to each of the items that may be present in the sealed box.
Using the available tools, generate and test hypotheses concerning the contents of your black box. Keep in mind that good experiments should only test one variable at a time, so you will need to conduct several experiments in order to come up with a complete list of the box's contents. Record your hypotheses, experimental design, data, and conclusions on the worksheet provided. Your instructor may ask you to turn in your worksheet at the end of class.

Check with your instructor before you leave to see if you were correct about the box’s contents. If you were not correct, what may have led to your erroneous conclusions? How could you have conducted the experiments differently to come up with the correct conclusions?

Example

Shake/tilt (gently), listen, feel the box, etc.

Observation: An object rolls as you tilt the box from side to side.

Hypothesis: There is a glass test tube in the black box.

Prediction: If there is a glass test tube in the black box, then I will hear the same rolling sound if I place a glass test tube in the empty box and tilt it.

Experiment: Place a glass test tube in the empty box. Tilt both the empty box with the test tube and the sealed black box and listen.

Experimental Data: Similar rolling sounds are heard in both boxes.

Conclusion: The hypothesis is supported.

**Think about whether you should test this same hypothesis again. Are you confident in one experiment? How else might you test this hypothesis?
Black Box Experiment Data Sheet

Observation:

Hypothesis:

Prediction:

Experiment:

Experimental Data:

Conclusion:

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Observation:

Hypothesis:

Prediction:

Experiment:

Experimental Data:

Conclusion: