

# Honors Biology

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# Chapter 1

## The Scientific Method

### 1.1 Steps to the Scientific Method

1. Make an Observation
2. Ask a question
3. Experiment: test the hypothesis and gather data
4. Analyze the data
5. Draw a conclusion

### 1.2 Characteristics of a Good Experiment

- Tests one variable at a time: If more than one thing is tested at a time, it won't be clear which variable caused the end result
- Fair and unbiased: Experimenter must not allow his or her opinions to influence the experiment
- Repeated trials: Repeating the trials in the experiment will reduce the effect of experimental errors and give a more accurate conclusion

### 1.3 Variables

**Definition 1.3.1 (Variable).** A variable is anything in an experiment that can change or vary

- Any factors that can have an effect on the outcome of the experiment

There are three main types of variables:

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**Definition 1.3.2 (Independent Variable).** The variable intentionally changed by the scientist

- What is tested or manipulated
- Only change on independent variable at a time

**Definition 1.3.3 (Dependent Variable (Responding Variable)).** Something that is affected by the change in the independent variable

- What is observed and measured (Data collected)

**Definition 1.3.4 (Controlled Variable).** Variables that are not changed, constants

## 1.4 Control Group

**Definition 1.4.1 (Control Group).** Group that isn't tested, but used for comparison as a reference for what "normal would be like"

**Definition 1.4.2 (Positive Control).** Group that you expect to give a positive result

**Definition 1.4.3 (Negative Control).** Group that you expect to give a negative result

Both ensure the validity of the experiment

## 1.5 Hypothesis

**Definition 1.5.1 (Hypothesis).** Proposed explanation for a set of observations

- Leads to predictions that can be tested in experiments
- Should be based off past experiments and background research
- Not only a prediction, not a research question, not a theory
- "If... then... because..."

## Chapter 2

# The Standard Deviation

**Definition 2.0.1 (Standard Deviation).** The extent to which the data are spread out from the mean, described as:

$$S = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

### 2.1 Error

The standard deviation error bars on a graph can be used to get a sense for whether a difference is significant. Overlap can show that the difference is not statistically significant.

**Definition 2.1.1 (Standard Error of the Mean (SEM)).** Measures how far the sample mean of the data is likely to be from the true population mean.

- Always smaller than the Standard Deviation
- Shows how accurate your estimate of the mean is likely to be

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$$