Chapter 1

* Introduction to the Scientific Method   
  Can Science Cure the Common Cold?

The Process of Science

* Science is not a giant collection of facts to be memorized.
* Process, using the **scientific method**:
  + Observing
  + Proposing ideas
  + Testing
  + Discarding those ideas that fail

**The Nature of Hypotheses**

* **Hypothesis**: proposed explanation
* **Testable** and potentially **falsifiable**
* Where do hypotheses come from?
* Both logical and creative influences are used

**Scientific Theory**

* Powerful, broad explanation of a large set of observations
* Rests on many hypotheses that have been tested
* Generates additional hypotheses

**The Logic of Hypothesis Tests**

* Example: consuming vitamin C decreases the risk of catching a cold
* **Inductive reasoning**: combining a series of specific observations into a generalization
* To test, make a prediction using **deductive reasoning**.
  + Involves using general principle to predict an expected observation
  + “if…then” statement
* A hypothesis that fails our test is **rejected** and considered disproven.
* A hypothesis that passes is **supported**, but not proven.
* Why not? An **alternative hypothesis** might be the real explanation.
* The most powerful way to test hypotheses: do **experiments**

**The Experimental Method**

* **Experiments** are contrived situations.
* **Variables**: factors that can change in value under different conditions
  + **Independent variables** can be manipulated by the scientist
  + **Dependent variables** cannot be changed by the researcher

**Controlled Experiments**

* **Controlled experiment**: tests the effect of a single variable
* **Control**: a subject who is not exposed to the experimental treatment
* Differences can be attributed to the experimental treatment.
* Example: *Echinacea* tea experiment:
  + Hypothesis: drinking *Echinacea* tea relieves cold symptoms
  + Experimental group drinks *Echinacea* tea 5-6 times daily.
  + Control group drinks “sham” *Echinacea* tea (**placebo**).
  + Both groups rated the effectiveness of their treatment on relieving cold symptoms.
  + People who received echinacea tea felt that it was 33% more effective at reducing symptoms.

**Minimizing Bias in Experimental Design**

* If human subjects know whether they have received the real treatment or a placebo, they may be biased.
* **Blind experiment:** subjects don’t know what kind of treatment they have received
* **Double blinding:** the person administering the treatments also doesn’t know until after the experiment is over
* “gold standard” for experimentation

**Using Correlation to Test Hypotheses**

* It is not always possible or ethical to experiment on humans.
* Using existing data, is there a **correlation** between variables?
* Hypothesis: stress makes people more susceptible to catching a cold
* Is there a correlation between stress and the number of colds people have caught?
* Caution! Correlation does not imply causation.
* The correlation might be due to other reasons.

**Overview: What Statistical Tests Can Tell Us**

* We can extend the results from small samples to an entire population.
* Difference between two samples: real or due to chance?

**The Problem of Sampling Error**

* **Sampling error:** the effect of chance
* We can calculate the probability that a result is simply due to sampling error.
* **Statistically significant:** an observed difference is probably **not** due to sampling error
* **Confidence interval:** the range of values from a sample that has a 95% probability of containing the true population **mean** (average).
* Much population variation = large confidence interval
* Small population variation = small confidence interval

**What Statistical Tests Cannot Tell Us**

* If an experiment was designed and carried out properly
* Evaluate the probability of sampling error, not **observer error**
* May not be of any biological significance

**Primary Sources**

* Researchers can submit a paper about their results to a professional journal (**primary source**).
* **Peer review:** evaluation of submitted papers by other experts
* **Secondary sources:** books, news reports, the internet, and advertisements

**Information from Anecdotes**

* **Anecdotal evidence** is based on one person’s experience, not on experimental data.
* Example: a testimonial from a celebrity

**Science in the News**

* Secondary sources may be missing critical information or report the information incorrectly.
* Consider the source of media reports.
* Be careful with the internet since anyone can post information.
* Be very cautious about claims made in paid advertisements.

**Understanding Science from Secondary Sources**

* Use your understanding of the process of science to evaluate science stories.
* News media generally highlight only those science stories that seem newsworthy.
* They are more likely to report a positive result than a negative one.

**Is There a Cure for the Common Cold?**

* No, but prevention methods are known.
* Wash your hands!
* No effect on cold susceptibility:
  + Vitamin C
  + Exposure to cold temperatures
  + Exercise
* No vaccine for the common cold