Hypothesis-Driven Science

- As a formal process of inquiry, the **scientific method** consists of a series of steps.
  - The key element of the scientific method is **hypothesis-driven science**.

![Diagram: Observation → Question → Hypothesis → Prediction → Experiment → Revise and repeat]

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Reporting the Results of Experiments

A **scientific research report** is a form of communication in which the investigator succinctly presents and interprets data collected in an investigation.

www.csub.edu/biology/Biology How to Write.pdf

- Abstract
- Introduction
- Materials and Methods
- Results
- Discussion
- Literature Cited

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Title

Clearly states the nature of the study and includes:

* environmental factors that have been manipulated
* response of the organism
* specific organism used (in scientific notation)

Not so good: A **Biology Lab Report**

Good: The Effects of Light and Temperature on the Growth of the Bacterium *Escherichia coli*

Also acceptable: Effects of Various Chemicals on the Growth of *Escherichia coli*
Introduction

• General background information relevant to the topic
• Information specific to your hypothesis
• A short description of the hypothesis
• A description of how you proposed to test the hypothesis
• Predictions of expected supportive for falsifying results

Materials and Methods

• Written in past tense
• Do not use narrative format
• Declarative statements of how the experiment was conducted
• Summarize the information, do not list materials as is done for a cooking recipe

Results

• Present data in straightforward manner with no analysis of the reasons the results occurred or the biological meaning of the data.
• Tables and Figures are often used (they must be accompanied by narrative text).

Be sure to include:
  * A general introductory sentence which tells the reader what you did for this experiment.
  * A clear description of the results
  * Supporting figures (a graph or a table)
Results: Figures

Tables and figures have two primary functions:
(1) Assist with analysis and interpretation of your results and
(2) Enhance the clarity with which you present the work to a
reader or viewer.

Table 1. Effects of 4-Hour Exposure to 0.6 ppm Sulfur Dioxide on Average Seed and Pod Production in Soybeans.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Number</th>
<th>Seeds per Pod</th>
<th>Pods per Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>24</td>
<td>3.26</td>
<td>16</td>
</tr>
<tr>
<td>S0₂</td>
<td>24</td>
<td>1.96</td>
<td>13</td>
</tr>
</tbody>
</table>

Discussion

• Attempt to explain the meaning of the results and how
the results relate to your problem or hypothesis posed in
the introduction.

Be sure to:
* Summarize the results
* Discuss how your results relate to another study
* Discuss factors that might not have been accounted
  for in the experimental design
* Not use a narrative format

Literature Cited Format

• The cited sources must be appropriate authorities on
  the topic the citation is used to support. Therefore use
  of Encyclopedias, Children's books, popular news
  journals, popular magazines, or web site information
  from web pages other than the online reference
  service provided by the Walter W. Stiern Library) are
  not appropriate citation sources.
Abstract

- This should be the last section written
- Summary of the report
  - Introductory statement: short description of the question investigated
  - A short description of how the experiment was conducted
  - A short description of the results
  - A summary set of statements explaining the relevance of the results

Abstract

An abstract, or summary, is published together with a research article, giving the reader a "preview" of what's to come.

Your abstract should be one paragraph, of 100-250 words, which summarizes the purpose, methods, results and conclusions of the paper.

Don't use abbreviations or citations in the abstract. It should be able to stand alone without any footnotes.

Conservation of Energy

Energy is defined as the capacity to perform work.
Kinetic energy is the energy of motion.
Potential energy is stored energy.

Climbing the steps converts kinetic energy of muscle movement to potential energy.
Diving converts potential energy to kinetic energy.

In the water, the diver has less potential energy.
Enzymes

- **Metabolism** is the total of all chemical reactions in an organism.
- Most metabolic reactions require the assistance of **enzymes**, proteins that speed up chemical reactions.

**Induced Fit:** Every enzyme is very selective, catalyzing a specific reaction.

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**Activation Energy**

- **Activation energy**
  - Activates the reactants
  - Triggers a chemical reaction
- Enzymes lower the activation energy for chemical reactions.

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**ATP and Cellular Work**

Main types of (cellular) work:
- mechanical
- transport
- chemical

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The Structure of ATP

- ATP (adenosine triphosphate)
  - Consists of adenosine plus a tail of three phosphate groups
  - Is broken down to ADP and a phosphate group, releasing energy

ATP $\rightarrow$ ADP + phosphate

The Structure of ATP

ATP and Cellular Work

(a) Motor protein performing mechanical work

ATP $\rightarrow$ ADP + phosphate

Protein moved

(b) Transport protein performing transport work

ATP $\rightarrow$ ADP + phosphate

Solute transported

(c) Chemical reactants performing chemical work

ATP $\rightarrow$ ADP + phosphate

Product made
ATP and Cellular Work

Redox reaction (oxidation-reduction)

Not all redox reactions involve the complete transfer of electrons:

NAD+ (another activated carrier)