Scientific Method

Plan for today’s lab

- Safety
- Frequently asked questions (Why, How, and What)
- Types of scientific investigations: Discovery & hypothesis-driven
- Scientific questions and steps of the Scientific Method

- Application
  - Cardiovascular fitness
Q1- Why do we need to study the living world?

A2- To search for information and explanation
Q2- How do we know about the natural world i.e. Biology?

A2- Through the process of scientific studies (inquiry)
Q3- What do we do to know about Biology?

A3- We choose an approach and a method.
Q4- *Is there more than one approach to study Biology?*

A4- Yes, there are two approaches: the reductionist and the systems biology
Two Approaches to studying biology at all its organizational levels

1. Reductionism- Breaking the system into parts and focusing on each separately.

2. Systems Biology- study of the emergent properties, based on knowledge about as many parts as possible.
Q5- Is there more than one method to study Biology?

A5- Yes, depending on whether it is to seek new information by pioneers, or to seek explanation based on existing knowledge.
Two Types of Scientific Studies (Inquiry)

1. Discovery Science – seeks information and describes nature through observation by pioneers

2. Hypothesis-based Science – seeks explanation for observations based on existing knowledge

Both arrive at conclusions using logic and reasoning!
Discovery Science

- Observations are made and recorded (data), may be qualitative or quantitative
  Examples: Cell description
  chimpanzee behavior
Hypothesis-based Science

- Seeks natural causes and explanation for observation (How & Why)
Example of application of hypothesis-driven Science to a campground problem
Hypothesis

Prediction

Test does not support hypothesis: revise hypothesis or pose new one

Test supports hypothesis

Test

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Figure 1.9A_s3

Hypothesis #1: Dead batteries
Prediction: Replacing batteries will fix problem.
Experiment: Test prediction by replacing batteries.

Hypothesis #2: Burned-out bulb
Prediction: Replacing bulb will fix problem.
Experiment: Test prediction by replacing bulb.

Test does not falsify hypothesis. Make additional predictions and test them.
Hypothesis

• A possible explanation for a well-defined question
• Proposed based on past experience and data made available through discovery science
• Leads to a prediction which can be tested- measurable and controllable
An explanation offered by a hypothesis must be for a question that is

- Well-defined
- Testable
- Measurable
- Controllable
Steps of hypothesis-driven scientific inquiry

1. Observation based on established knowledge
2. Question
3. Hypothesis
4. Prediction (if……then) testable
5. Design and conducting experiment (controlled)
6. Obtaining results (data)
7. Analysis & Conclusion (whether data supports or does not support the prediction and the hypothesis)
8. Revision of hypothesis (if necessary)
Theory

• A broad statement about a comprehensive concept
• Spins off many specific hypotheses that can be tested
• Supported by much larger body of evidence than a hypothesis

Example: The Cell Theory
A person with high cardiovascular fitness has relatively lower resting pulse rate and a lower respiratory rate increase after exercise, and his or her pulse rate returns to normal faster than a less fit person.
Designing an Experiment

Cardiovascular fitness
Determined by
1. Increase in pulse rate after exercise.
   Measure PR before (resting) & after aerobic exercise
2. Recovery time to resting pulse rate.
Measure Heart rate for 30 seconds

1 minute

0 minutes 1 minute 2 minutes 3 minutes
Variables

- Independent Variable:
- Dependent Variable:
- Controlled Variable
- Uncontrolled Variable

Any variable can only be one of the above!
Presentation of Results

• Tables
• Figures
  – Picture
  – Diagram
  – Graph
    • Bar graph
    • Scatter plot
    • Line plot
## Formatting of Tables

Table #. Title

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<thead>
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<th>Independent variables</th>
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Formatting of a Figure that includes a Graph

Figure #. Title