Lesson Plan 01 – Purposes and Methods of Biology

General Information:
Teacher: Stephanie Mitchell                  Date: Fall 2010
Subject: School of Choice Biology           Grade: 11 and 12
Lesson Theme: Purposes and Methods of Biology
Length of Lesson: Two or three 100-minute blocks

Preparation Before Class:
Standard/Benchmarks:
I.I. Understand the processes of scientific investigations and use inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.
III. Science and Society
   Identify how science has produced knowledge that is relevant to individual health and material prosperity.
   Know that science plays a role in many different kinds of careers and activities (e.g., public service, volunteers, public office holders, researchers, teachers, doctors, nurses, technicians, farmers, ranchers).

Objectives. Students will

Content
Knowledge:
• Know that biology is the study of life.
• Know that all living things share common characteristics.
• Know how biologists benefit society.
• Know careers in biology.
• Know that biology research expands understanding of how the natural world works and aids development of helpful technology.
• Know the steps of the scientific method.
• Know that lab reports are important tools in science.
Understandings:
• Understand that defining life is difficult.
• Understand the importance of writing accurate, thorough lab reports.

Process Skills:
• Compare living and nonliving objects.
• Look up vocabulary terms in a glossary.
• Find common characteristics of living organisms.
• Research careers in biology.
• Discuss and evaluate findings with other students in a respectful manner.
• Be able to write a valid hypothesis based on observations.
• Design an experiment based on a testable hypothesis.
• Conduct an experiment to test a hypothesis.
• Write a high quality lab report.
Day 1 – Purpose of Biology:

Key Vocabulary:
- Biology, organism, organization, reproduction, species, growth, development, environment, stimulus, response, homeostasis, energy, adaptation, evolution, ethics, technology

Anticipated Misconceptions: (and how you will avoid or correct them)
Students may believe that objects that move on their own are living. A watch will be used as an object that moves on its own that is nonliving; lichen will be used as a living thing that does not move.
Students may believe that objects that consume energy are living. A fire will be used as an example of a nonliving thing that consumes energy.

Materials, Texts, Worksheets, and/or Other Resources:
- Text: Glencoe Science, Biology, The Dynamics of Life
- Materials for comparison: A rock with lichens, a bird’s nest, a potted plant, seeds, a watch, a lit candle
- Student Handout: 01-A-Purpose of Biology.pdf

Procedures in Class:

Introduction 30 minutes
Give students list of vocabulary terms. Students should look up unfamiliar terms and write definitions in notebook.
Give students list of questions.
1. What is biology?
2. What is life?
3. What characteristics are common to all living things?
4. What are possible benefits from studying biology?
5. What are some careers in biology?
6. How do biologists’ research contribute to our understanding of the world?
Students should spend 30 minutes researching the answers to the above questions and writing their findings in their notebooks.

Discussion 30 minutes
Students sit in small groups and compare answers.
Teacher will write best answers on board.
Students will write best answers in their notebooks.

Investigation – Alive or Not 30 minutes
Teacher sets up stations around the classroom with living and nonliving items such as a rock with lichen, a bird’s nest, a potted plant, seeds, a watch, and a lit candle.
Students decide if each item is alive or not and justify their answers.

Review/Closure: (What did you learn today?) 10 minutes
Students spend last 10 minutes of class writing in notebook summarizing what they learned in class and what they would like to learn more about.

Evaluation
Teacher collects and grades notebooks.

- Organization: The assignment has four sections: vocabulary, answers to questions, summary of best answers, investigation, closure. Each section is titled.
- Content: The teacher should read each section to ensure content is accurate.
- Feedback: The teacher should make comments on how student could improve notebook organization. The teacher should correct inaccuracies.

Day 2 – Methods of Biology

Key Terms
Scientific methods, hypothesis, experiment, control, independent variable, dependent variable, data, theory, deductive reasoning, inductive reasoning, observations, controlled experiment, field study, quantitative data, qualitative data

Materials, Texts, Worksheets, and/or Other Resources

- Resources: Text: Glencoe Science, Biology, *The Dynamics of Life*
- Materials: Internet access, Petri dishes
- Student Handouts: 01-B-Laboratory Notebook Guidelines.pdf, 01-C-Design an Experiment.pdf

Source for lab history and guidelines:

Procedures in Class:

Introduction 15 minutes

Review the steps of the scientific method and use example.

1. Observing Mrs. Green has lots of tomatoes.
2. Making a hypothesis The fertilizer that she uses makes them grow well.
3. Designing an experiment Grow three tomato plants. Add Mrs. Green’s fertilizer to one plant. Add a different fertilizer to one plant. Use only water on one plant.

4. Collecting data Record plant growth and number of tomatoes over time.

5. Analyzing data Plot number of tomatoes per time for each plant.
6. Drawing conclusions from data Which plant grew the most tomatoes?
7. Considering further experiments How does the amount of sunlight and water affect
the growth of tomatoes? How about the quality of the soil? What other factors may affect tomato growth?

Ask students to explain why the experiment used three plants instead of only one or two. Ask why one plant was given only water. Ask students how they would record data and how they would plot the data.

Investigation/Discussion 30 minutes
Discuss the importance of keeping accurate laboratory notebooks.

- Students search internet for the phrase “laboratory notebook guidelines”. Cooperative groups compile, compare, and present the commonalities in their findings.
- Read: “Leonardo da Vinci’s lab notebooks sell for millions of dollars. Jeffery L. Bada used Staney Miller’s notebooks after his death to identify specific amino acid samples generated in 1953 during Miller-Urey experiment. Using current analytical techniques and the 1953 samples identified by Miller’s notebooks, Bada detected 22 amino acids - more than twice the number that Miller was initially able to detect. The updated results were published in 2008, and have scientists rethinking the origin of life’s building blocks – 55 years after the experiments were conducted.” (Chang 2008)
- Scientists at Medichem were competing with other labs to develop and patent a way to produce the active ingredient in Claritin. Even though they made the discovery, they did not follow the standard procedures for documenting data or counter signing. Their poor notebook practice was cited as the reason that the pharmaceutical manufacturer lost a multimillion dollar patent lawsuit to Rolabo for the production of Claritin (Medichem v. Rolabo 2006). Ask students to talk about the consequences of notebook practice for this company and the scientists involved.
- The lab notebook’s purpose is as a personal journal and as a public (and potentially legal) document. Everything inside a lab notebook is there to guarantee the repeatability of procedures; document thinking and practice; and ensure the quality, integrity, and authenticity of the data collected. This practice reinforces the nature of science as a collaborative pursuit based on evidence.

Discuss laboratory handout: 01-B-Laboratory Notebook Guidelines.pdf

Laboratory – Student Handout: 01-C-Design an Experiment.pdf 55 minutes
Materials: One Petri dish per student, lab notebooks
Procedure:
1. Students should collect one living specimen from the wooded area outside the classroom, and place the specimen in the Petri dish (e.g., insects, spiders, worms, leaves, lizards, lichen). Safety concerns: Organisms should not be released inside the classroom. Students should wash their hands after handling organisms in case of allergic reactions.
2. Students should follow laboratory guidelines and make observations about the collected specimen. Observations may include size, shape, color, texture, sound, smell, and behavior. Students should be specific and record quantitative and qualitative data.

3. Students should ask questions about their specimen. What would they like to know about it? (e.g. Why is it grey? What does it eat? How does the texture help it survive? What is the range of size of this organism in the environment?)

4. Students should write a testable hypothesis about their specimen. Have students share their hypotheses with the class. Discuss whether each hypothesis is valid or not. Is there a way to test it? Can the hypothesis be proven false? Help students modify their hypotheses to ensure each one is valid. Discuss deductive reasoning (arguing from observation, specific to general) and inductive reasoning (arguing from general to specific).

5. Students should design an experiment that would test their hypothesis.

6. Students should create an appropriate data table for their experiment.

7. Students should write a concluding paragraph explaining what they expect to discover from their experiment.

8. Students should release their organism in the approximate area that the organism was found.

9. Students should have a peer review his notebook according to the peer review guidelines.

Evaluation
Teacher collects and grades notebooks.
- Organization: The assignment has these elements: title, date, observations, questions, hypothesis, experiment design, data table, and conclusion. Each section is titled. The assignment is written in ink.
- Content: The teacher should read each section to ensure content is detailed, accurate, and reproducible.
- Feedback: The teacher should make comments on how student could improve the lab report.
- Teacher should review labs to see if the class could complete any of the experiments. If possible, the teacher should assemble necessary materials, copy best lab experiment, and have students conduct the experiment.

Day 3 – Conducting Student Experiment
Preparations before class:
- Teacher should assemble necessary lab materials.
- Teacher should make copies of a student’s experiment.

Procedures during class:
Discussion 15 minutes
Students should read student’s lab report. Students should discuss the hypothesis and the experimental design. Students should write their own hypothesis based on the lab
report. Students should discuss improvements that could be made to the experiment to test the hypothesis. Students should predict the outcome of the experiment.

**Laboratory** 85 minutes
Students should begin the lab write-up and rewrite the procedure in their own words. A peer should evaluate the student lab report. Students should conduct the experiment in groups of three. If the experiment will take several days, allow the time at the beginning of the necessary class periods.

**Evaluation**
Use lab rubric to evaluate