Draft 19 September 2012

Interns: we will be updating this report outline several times over the course of the year to highlight (in black text) the next sections to be completed. However you should read the entire outline to understand the structure of the report. This report is very similar to lab reports that you will complete in science classes in college, so you are getting a head start on learning how to write them.

Lassen Astrobiology Intern Program
Report Outline
2012 – 2013 school year

One of the requirements of the 2012-2013 Lassen Astrobiology Intern Program is to complete a report based on your fieldwork and your group research project in the lab, which is due to the Ames team in April 2013 (date to be announced). You will then use this report to construct your final 15 minute oral presentation for the Astrobiology Intern Recognition Night in May 2013 (date to be announced). This oral presentation should follow the same format as your report (Introduction, Methods, Results, Discussion), and will be given in front of your family, friends, and community members who attend the evening event at Red Bluff High.

Below is an outline that you can follow to help you write your reports. There are specific items that we want you to include. For example, the Introduction should contain a summary of the introductory lectures that we gave you in the fall. This sets the proper background and context for your interpretation of your field observations and your lab-based research projects. We want you to understand the "big picture" of why you're doing this work, how it relates to Lassen, and how it relates to the search for evidence of microbial life on Mars.

To be clear, each student must hand in their own report written in their own words. However we encourage everyone to work together in discussing the items below, and we encourage the Acid, Neutral, and Alkaline groups to work together in plotting their data and writing the Results and Discussion sections.

I. INTRODUCTION
The purpose of the introduction is to give the readers a big picture idea of the report they are about to read. It should provide the proper background and context for the hypotheses to be tested.

A. Astrobiology and Lassen Volcanic National Park
We are giving this first introductory paragraph to you as a "freebee." We want to make sure that you understand the big picture context of the whole intern program, and why NASA is interested in Lassen Volcanic National Park.

Astrobiology is the investigation of the origins, distribution and future of life in the Universe. A key aspect of astrobiology is to search for and characterize the full diversity of habitable environments, both on early Earth and on other planets. Volcanic activity and its interactions with water are key aspects of ancient habitable environments on Earth. Evidence such interactions have been discovered on Mars and they probably occurred on other Earth-like planets in the universe. Lassen Volcanic National Park provides field sites were volcanic processes interact with water and also host microbial life. The Lassen Astrobiology Intern program explores how volcanism, water, and life interact to sustain microbial ecosystems. These ecosystems provide important examples of the kinds of evidence that astrobiologists seek on Mars as wells as other potentially habitable planets.

B. Field site in Warner Valley

Please write 1-2 sentences on each item listed below:

1. Volcanism
    a. Volcanoes surrounding Warner Valley. *Mr. Zachary will address this during the field trip to Cinder Cone on Tuesday, October 30.*
2. **Water *(you can refer to the USGS handout entitled, "Hot water in Lassen Volcanic National Park—fumaroles, steaming ground, and boiling mudpots")***
    a. In general, describe the path of water in Warner Valley. Where does the water come from? Where does it go?
    b. Hydrothermal activity – in general describe how the hydrothermal system in Warner Valley works. What are some of the important gases that the water picks up from the magma body deep underground? How do these gases make the water at Devil's Kitchen acidic?
3. Habitable environments for microorganisms at acid, neutral, and alkaline pH field sites. *Niki will address this during her lectures on Monday, October 15.*
    a. What are the key requirements for microbial life?
    b. Describe how the microbes in these sites are interacting with the water and rocks.
4. Laboratory experiments that explore key features or processes observed in the field. What are your hypotheses? *The Ames group will address this on Monday, October 29, and Monday, November 26.*
    a. Acid group
        i. Rock dissolution experiments
        ii. Microbe culturing and characterization
    b. Neutral group
        i. Rock dissolution experiments
        ii. Microbe culturing and characterization
    c. Alkaline group
        i. Rock dissolution experiments
        ii. Microbe culturing and characterization

II. METHODS

The methods section is a description of the equipment that you used to collect samples and take measurements in the field, a description of how you set up your laboratory experiments, and a description of the equipment used to make measurements of, or analyses performed, of

your lab experiments. Pretend that you're writing instructions for someone else to replicate your fieldwork and lab experiments – that's the type of information that should be included.

1. **Recording visual observations made at acid, neutral, and alkaline field sites**
    a. **Each group should describe the types of general observations that you recorded at your site in your notebooks (e.g., the kind of plants, rocks, types of water bodies, landscape, etc.).**
        i. **Acid group – acid field site**
        ii. **Neutral pH group – neutral pH field site(s)**
        iii. **Alkaline group – alkaline field site**
2. **Field measurements of temperature, pH, and conductivity**
    a. **Describe the types of instruments that you used to measure temperature, pH, and conductivity and write a one-sentence description of how each works, or what exactly it's measuring. Hint: pH (hydrogen ions), conductivity (http://en.wikipedia.org/wiki/Conductivity_%28electrolytic%29)**
3. **Field collection of water samples and microorganisms**
    a. **Describe the how you collected these samples. How did you collect the cation and anion water samples? Why did you filter them? What supplies did you use? How did you collect the samples of microbes? What supplies did you use?**
4. Laboratory experiments. *The Ames group will address this on Monday, October 29, and Monday, November 26.*
    a. Acid group
        i. Rock dissolution experiments
        ii. Microbe culturing and characterization
    b. Neutral group
        i. Rock dissolution experiments
        ii. Microbe culturing and characterization
    c. Alkaline group
        i. Rock dissolution experiments
        ii. Microbe culturing and characterization

III. RESULTS

Your results are the actual data that you will have measured (or have measured for you). For clarity's sake, you should report your data both in a graphical (chart) or numerical (table) format, as well a one-paragraph description of your data (e.g., the pH decreased by X over the course of Y days). Also remember that the results section is just a straightforward listing or description of your data – do not try to interpret what it means in this section. We will begin to work on this section in January.

1. List field measurements.
    a. Acid group
    b. Neutral group
    c. Alkaline group
2. List results from your laboratory experiments.

a. Acid group
    i. Rock dissolution experiments
    ii. Microbe culturing and characterization
b. Neutral group
    i. Rock dissolution experiments
    ii. Microbe culturing and characterization
c. Alkaline group
    i. Rock dissolution experiments
    ii. Microbe culturing and characterization

IV. DISCUSSION

The discussion section involves talking about or interpreting your results, and discussing whether or not your hypothesis was correct. It also involves placing your results within the context of the "big picture" of the project – how Lassen relates to Mars, and how your results might help direct the search for evidence of microbial life on Mars. You will want to make notes from now on to help you write this section, but we will begin to write it in February.

1. Discuss or provide interpretation of your field observations and lab-based experiments. Were your hypotheses correct? Why or why not? Contrast the results of your group to the other group's data. What trends in pH and temperature do you see emerging?
    d. Acid group
        i. Rock dissolution experiments
        ii. Microbe culturing and characterization
    e. Neutral group
        i. Rock dissolution experiments
        ii. Microbe culturing and characterization
    f. Alkaline group
        i. Rock dissolution experiments
        ii. Microbe culturing and characterization
2. "Big picture"
    a. Discuss the field study sites in the context of what a "habitable environment" is.
    b. Discuss the unifying theme of how water interacts with the rocks to release elements into solution, and how that impacts the microbial populations.
    c. Discuss the application of your findings to astrobiology and the exploration of Mars.