Laboratory: Research for our Public Service Campaign --- Osteopenia, Osteoporosis and Osteomalacia

(written by Kris Young, Parkland College, revised by Laura Sonnichsen and Virginia Lehmann, Parkland College)

**Report Requirement**: Directions on how to write up the lab report can be found in the report section of the lab. There are two parts to this lab report. The “Lab – Osteo Report Part 1 MUST be submitted before being able to access Lab – Osteo Part 2 Drop Box for your formal report. I strongly suggest that you complete and submit Part 1 as early as possible to help you plan your experiments.

Labs not submitted in the appropriate format or drop box will *not* be graded.

**Report Scoring**: 20 points total.

Lab – Osteo Report Part 1: 5 points
Lab Osteo Part 2 Drop Box: 15 points

**Working with a Partner**: You are permitted to work with a partner. If you do so, the experimental data reported may be the same, but you need to write your own answers to each question. At the beginning of each question you should note that you worked with a partner by writing “Lab Partner (fill in name).”

**Goals**:
1. To apply concepts learned in class to design an experiment to demonstrate the loss of calcium from bones.
2. To conduct an experiment and collect data.
3. To analyze experimental data collected.
4. To communicate the experiment in a manner the general public can understand.

**Materials Needed**:  
Electronic balance (Found in Lab Kit)  
Beaker – 250 mL (Found in Lab Kit) – the beaker should be used as a balance pan.  
Graduated Cylinder (Found in Lab Kit)  
Thermometer (Found in Lab Kit)  
Cups or jars (several)

**Chemicals & Supplies Needed**:  
cooked and cleaned chicken bones (chicken wings may be the easiest source, but certainly regular chicken bones will do)  
vinegar  
optional: dish soap
optional: bleach

A Note from Macy Morgenstern
As I have mentioned in other communications, it is time for our Clinic’s annual public service campaign. This year, we have chosen to focus our efforts on educating the public about the two types of osteopenia: osteoporosis and osteomalacia.

While many are familiar with the osteoporosis, most are unfamiliar with osteopenia and osteomalacia. And most do not know how severe osteoporosis and osteomalacia can be, nor do they really understand what happens to bones in both these diseases. That is why I am asking you to run some experiments to remove calcium in order to demonstrate the role of calcium in bones.

Instead of a formal write-up, I ask that you inform the clinic of your findings so we can use data to inform the public about the problem. Specific directions are given below, but the goal of the project is to educate the public, and to draw on the results of your experiment to provide the public with some powerful evidence of the dangers of not getting enough calcium and vitamin D into their diets.

Thank you for your help,

Dr. Morgenstern

Background Information
In recent years, the medical profession, schools, the media, and advertisements have broadcasted the importance of the inclusion of calcium in our diets in order to promote strong bones. Big deal and so what? What happens to bones if calcium is not present?
In order to find out, you will design an experiment to remove calcium from cooked chicken bones in order to observe any changes in the bone's characteristics. Your experimental design must be based on the scientific method. A basic experiment is given below to guide you.

You should carefully and completely read the background information and example hints given below in order to get ideas for your self-generated lab procedure.

As you design your experiment, keep this purpose in mind:

**Purpose:**
The two purpose of this experiment are to observe chicken bones both before and after calcium has been removed from them in order to make observations regarding the importance of the role of calcium in bones and to make observations about either how time or temperature affects the removal of calcium from bones.

**The Science:**
Calcium (Ca) is a silvery, metallic element. If so, how is it that milk and bones, which both have “calcium”, are not the color of coins or conduct electricity? This is because the calcium that is in bones and in milk is actually part of a compound. A compound is a chemical that contains more
than one element. In this experiment, we are interested in calcium containing compounds, not just plain elemental calcium.

Bones contain calcium in the form of the compound calcium hydroxyapatite, \( \text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2 \). Calcium hydroxyapatite is a solid. We will use vinegar to cause a reaction that will break apart calcium hydroxyapatite (in a very complex acid-base reaction) and make several components. The following equation simplifies the phosphate component into just dihydrogen phosphate (the actual phosphate species are very dependent on the pH of the solution, but you do not need to worry about this).

\[
\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2 + 14 \text{HC}_2\text{H}_3\text{O}_2 \rightarrow 10 \text{Ca}^{2+} + 14 \text{C}_2\text{H}_5\text{O}^- + 6 \text{H}_2\text{PO}_4^- + 2 \text{H}_2\text{O}
\]

This reaction simplifies calcium hydroxyapatite (solid) with vinegar (acid) to form calcium cations (\( \text{Ca}^{2+} \)), acetate anions (\( \text{C}_2\text{H}_5\text{O}^- \)), dihydrogen phosphate anions (\( \text{H}_2\text{PO}_4^- \)), and water (\( \text{H}_2\text{O} \)).

While none of the products are visible to the eye, you have indeed broken apart calcium hydroxyapatite, the solid material responsible for forming durable bone material. Once calcium hydroxyapatite is removed from bones, you can study the bones to see how they have changed to see what role calcium plays in bones.

**Suggestions to consider:**

**Cleaning the Chicken Bones**

The cleanliness of your chicken bones is up to you. I recommend at least stripping the bones of meat as much as possible and soaking them in soapy water. This will allow you to strip away some of the tougher meat from the bone.

If you wish, you may also then soak the bones in a water/bleach solution. Use just a little bleach in some water and allow your bones to soak, and then rinse the bones well in plain water. This process will whiten the bones considerably. The whiteness will not affect the results of your experiment so long as you thoroughly rinse the bleach solution from the bones.

**Doing the Lab**

The lab is as easy as placing several bones in vinegar after first noting initial observations and then taking them out days later noting final observations. But even this simple idea raises many questions, such as:

1. How can I describe the bones qualitatively (observations/data using words), both before and after the experiment?
2. How can I describe the bones quantitatively (observations/data using numbers), both before and after the experiment?
3. What can I use as a control bone? How would the control be set up?
4. How much vinegar should I use?
5. How long should the experiment run?
6. Where should I place the containers?
7. At what temperature should the bones kept during the experiment?
8. What evidence do I have that calcium has been removed from the bones?
Remember the Purpose:

The two purpose of this experiment are to:

- observe chicken bones both before and after calcium has been removed from them in order to make observations regarding the importance of the role of calcium in bones and
- observe how either time or temperature affects the removal of calcium from bones.

Procedure:

1) Experimental Design: Re-read the purpose of the lab. For this lab, you are asked soak cooked chicken bones in vinegar as the experiment. Read this procedure, then complete Part 1 online. Part 1 is background to help you plan the experiments and Part 2 is reporting on your experiments. Consider questions 1-8 above as you design your experiments. It is suggested to email your instructor with your experimental design ideas to make sure you are on the right track. Make sure you have at least 1 control bone.

Use the following to design your experiment and then complete Lab- Osteo Report Part I. Do not perform the experiment until you’ve completed Part 1.

a. Experiment 1 Hints: The first experiment just asks to see the effects of vinegar on a chicken bone since vinegar should remove some calcium. Be sure to have a control to compare to. Think ahead of time about what observations – both qualitative and quantitative – should be made both before and after the bone or bones soak. As noted below, 24 hours is the absolute minimum a bone should soak in order to get measurable results.

b. Experiment 2 Hints: The purpose here is to see if calcium depletion is affected by the length of time of soaking in vinegar OR if calcium depletion is affected by the temperature of soaking in vinegar. Choose ONE variable (time or temperature) and vary it in two different ways when repeating the initial experiment (or better yet, if you carefully plan, you can use your experiment 1 bones as part of this experiment too to save time). Keep all the other experimental details the same as the initial experiment.

For examples, suppose we chose the variable of different solvents (which is NOT what you’ll do) instead of time or temperature. This means we wanted to study what other compounds could remove calcium besides vinegar. So we would choose two other chemicals such as pop and milk to use in place of the vinegar. We would then place the bones in the same amount of pop and milk for the same amount of time and in the same location. We would collect the same data as the initial experiment.

However, for your experiment, you MUST use time or temperature as your variable – you will NOT be choosing different solvents like the example just
You should have at least 3 trials/bones in vinegar for this part plus at least 1 control. Again, feel free to use your experiment 1 bone(s) as a trial here.

c. **Hints on both experiments:** Scientists often run multiple experiments to look at how various conditions affect the results of an experiment so, as mentioned, feel free to run your experiments side by side at the same time. This means you can feel free to use your bone from experiment 1 as one of your trial bones for experiment 2 so that you only need 2 more bones for experiment 2. This will save time and money.

2) **Performing the Experiment:** Once you are confident in your experimental design and have completed part 1 online, perform your experiment. The experiment starts with initial observations and data collection. As you do the experiment, document your actions and findings very well so that you can recall what you did. Good documentation will help you interpret your results later. One hint is that there should be a noticeable change in the bone after soaking in vinegar, which will help you make conclusions. If you don’t see a change, run the experiment for longer. *Make sure you’ve completed Part 1 before you start your experiment.*

*Note that for best results, the bones should be exposed to vinegar for at least 24 hours. Exposure for one week gives the very best results.*

Perhaps your experiment will look something like this:

![Image of bones and vinegar](image1.jpg)

Look at how one set of example experiments turned out!

As before, take great notes on what you are doing, and keep the purpose of this lab in mind.

**Report**

As per Dr. Morgenstern’s request, you will be asked to write up a report to show about the effect of calcium depletion on bones. By providing a report you are helping Dr. Morgenstern get the evidence she needs to educate the public. Please provide the following information:
Paragraph 1 (2.5pts) INTRODUCTION: For this section:
   a. Briefly summarize the background information on osteopenia, osteoporosis, and osteomalacia and cite your credible source (Note: Failure to cite your sources is plagiarism and you will receive a zero. Wikipedia is not considered a credible source but may help you find a credible source.);
   b. State the purpose of the experiments;
   c. Include what observations/data collection will be made in general (i.e. “Density will be used to consider the effects of…”);
   d. Include your two hypotheses in the form of:
      i. Soaking a chicken bone in ________________ ml of vinegar for __________________ hours at ________________ temperature will cause the chicken bone to display characteristics of ________________ (osteomalacia or osteoporosis-PICK 1!).
      ii. Increasing the amount of ________________ (time or temperature – PICK 1!) for soaking a chicken bone in ________________ ml of vinegar will cause the chicken bone to display ________________ (increasing/decreasing – PICK 1!) characteristics of ________________ (osteomalacia or osteoporosis-PICK 1!).

Paragraph 2 (3pts) PROCEDURE: how we removed calcium from bones. For this section:
   a. Tell readers how you did your experiments IN DETAIL. You should describe your experiments in good scientific detail including what materials were used, what you did (Step 1, Step 2 …) what control you used, conditions of ALL bones, etc. The readers should be able to replicate your exact experiment. Do not include observations and results yet – they will be in the next section. BE DETAILED.

Paragraph 3 (7pts) DATA/OBSERVATIONS/RESULTS/CALCULATIONS from the clinic – what we observed when performing experiments and what these results mean. For this section:
   a. Clearly describe your observations (both qualitative and quantitative) and explain your results from a scientific perspective. This should be done in data table form (further explanations can be provided in paragraph form below if desired) and should include:
      iii. Pre-experimental observations, measurements, data (don’t forget units and sig figs!)
      iv. Post-experimental observations, measurements, data (units! Sig figs!)
      v. Show work for any calculations performed.
      vi. Changes in data (i.e. increase or decrease in data)
      vii. Make sure all headings are specific so that data is easily interpreted
   b. NOTE: If you take any type of measurement, include it in your data table. If do any type of math, show it in your calculations.
**Paragraph 4 (2.5pts) CONCLUSION: What happened & how can you protect your bones?**

For this section:

b. State which condition, osteoporosis or osteomalacia, your experiments most closely duplicated and why you said that (i.e. what data suggested it). In other words, clearly state if your hypotheses are accepted or rejected.

c. Point out any data that is suspect or unclear.

d. Finally, make some brief recommendations for patients **BASED ON YOUR RESULTS ONLY**

You should write your report for into a word processing program and save the file either as a Rich Text Format (.rtf), Word document (.docx or .doc) or PDF file (.pdf). Submit the file in the drop box for Lab-Osteo. Labs not submitted in the appropriate format or drop box will **not** be graded.

**See Rubric on Cobra for specifics on grading**

This lab was written by Kris Young, Parkland College and revised by Laura B. Sonnichsen and Virginia Lehmann, Parkland College. You are welcome to distribute the lab so long as credit is given. Ver.011013