Reflections on Engagement of Undergraduate Researchers – Preparing for 'Success'

Dwight R. Stoll – February 23, 2017

The following ideas represent the distillate of what I have found 'works' in my engagement of Gustavus students in my research. I don't pretend that it is the 'best' or 'only' way, and fully recognize that what 'works' will vary substantially by discipline, faculty member, and other variables. This is simply meant to share what I have learned over the years, with the hope other folks might benefit from some of the ideas in the future.

1. Begin with the end in mind, by discussing the following points with prospective students.
   - What expectations do I have for 'products' at the end of the engagement?
     - ➢ Simple opportunity offering
     - ➢ Achievement of specific research objectives (e.g., Aims of a NSF-funded project)
   - What expectations does the student have for the experience?
     - ➢ $$, credit, experience, exploration?
2. Walk before running.
   - Start each new student with a kind of 'shadowing' experience that serves as a 'get-to-know-you' period. This is a low-stakes interaction that yields some baseline information.
     - ➢ Typically pair the new student with a more experienced student
     - ➢ Typically average of 1-2 hours/wk for one semester or J-term
     - ➢ Ask the new student to execute a 'rookie exercise' involving some lab work and data analysis – assessment of skill level, ability to follow instructions, document their work. I give them minimal input outside of the exercise instructions, but observe the work closely.
     - ➢ Find out whether they are comfortable working with me, and me with them – interpersonal dynamics
     - ➢ Assess reliability, accountability, consistency – are they interested enough to keep showing up at scheduled times?
3. Match student interest/aptitude/commitment with project needs and available resources.
   - Develop a shared sense for the future before committing to a more serious interaction (summer, semester, J-term; 3-10 hrs/wk)
     - ➢ How long will this engagement last? One semester/summer/J-term? Multiple semesters? Potential for multi-year?
       - o There are multiple factors that can be important here. I emphasize that I try to remain flexible and allow students to 'opt out' at any time, as long as they recognize that managing real science is not trivial, and they should take my investment in them seriously.
     - ➢ 3 hrs/wk is minimum to make any real progress – anything less is a poor use of time for everyone involved; I find very few students can really commit more than 10 hrs/wk – planning for more may conclude with disappointment.
     - ➢ Credit or $$?
       - o My experience is that credit is only suitable for the most serious students
       - o $$ works nicely – if they don't show up, they don't get paid

- I work hard to align my project needs with student interest and aptitude. For example, if I have a need to do some simulation work, I try to identify a student with interest and aptitude in both chemistry and computer science. Likewise, if I have a need for a highly technical hands-on experiment where high attention to detail is needed, I will wait for the ‘right’ student with those attributes/skills. I try to balance pushing the student to learn something new with leveraging their strengths without pushing them too far outside of their box.

4. Employ a mechanism to regularly assess performance and provide feedback, with the goal of continuous improvement.

    - For students working more than 4 hrs/wk, I ask them to submit a written update on their work each week. I find this incredibly helpful for assessing how students perceive their work (e.g., effort, enthusiasm, frustration), and finding out when barriers are encountered. For me this is important for maintaining productivity.
        - What was learned?
        - What challenges were encountered?
    - Two or three times per semester I meet with students to do a kind of ‘performance evaluation’, where I explicitly discuss strengths and weaknesses, and work with the student to articulate a plan for performance improvement.
        - Communication skills
        - Record keeping skills
        - Execution as an experimentalist or theoretician
        - Commitment level

5. Be patient. Professional development for young scientists is kinetically limited.

Suggestions for a Positive Geology Research Experience

Adapted from M. Bloch Qazi's "Eleven suggestions for a productive research experience in the Bloch Qazi lab"

(Distributed with permission from Dr. Julie Bartley)

Research is a process of discovery – about the natural world and about yourself. Beyond opportunities to learn about a particular geological topic and research methods, the process of scientific investigation gives you a chance to reshape how you think and communicate. Research can be a wonderful (if sometimes maddening) experience; some people love it and can't get enough, while others… well… not so much. This document is intended to help you develop habits of practice that favor a successful (safe, productive, positive) research experience. With this in mind, I recommend that you be…

Safe

Your safety and that of other members of our research community is of paramount importance. Know what chemicals are being used in the lab and where the MSDS (material safety data sheets) are located. Do not eat, drink, or chew gum in a lab that prohibits food for safety reasons. Know where broken glass goes (nope…not the trash) and clear up any broken glass or spills promptly. Please let your mentor know if you have health issues that might affect your safety in lab or in the field (latex allergies, insect allergies, diabetes, fainting, etc.). If you work in the lab at night, you should have a buddy with you. Know the location of the (1) eyewash; (2) safety shower; (3) fire extinguisher; (4) telephone; (5) emergency phone numbers.

Proactive

You should have a timeline for your work, and you should also understand that the timeline is dynamic – it will change as you work. Anticipate the next steps: What kinds and amounts of materials will you need? What skills or training will you need? Do you have a sense of what you will do with the data you generate? What experiments or analyses will be completed next?

Prepared

To paraphrase the biologist Louis Pasteur, *chance favors a prepared mind*. To increase the probability that your research will yield useful results – a novel discovery, an insightful observation, or a critical flaw – you should learn as much as you can about what you are doing. This is especially important if this work will form the data for your senior thesis, but it's also important no matter the context for the research you're doing. Be proactive (see above), ask questions, find and read relevant material, discuss and think about your work and its context. You should also be prepared to make mistakes and that your work may go more slowly than you anticipate. Have the perspective that every mistake is an opportunity to learn something new.

Responsible

Demonstrate stewardship for your experiments and for the laboratory by

- Maintaining an up-to-date, well-organized, neat, and accurate lab and/or field notebook.
- Promptly wash and put away materials, using the proper dishwashing procedures.
- Turn off and return equipment to its rightful location when you are done.
- Alert a mentor when materials are low but **before** they are gone.
- When, inevitably, something breaks/gets depleted/needs remedy, tell your mentor promptly (preferably in person) and ask how you can help be a part of the solution.

Respectful

Other people share your work space and everyone is very busy. Kindly respect others'

- *Time*: arrive promptly to meetings and honor due dates and deadlines. Depending on the nature of the deadline and type of due date, these can frequently be modified by prior arrangement. It's not okay to cancel at the last minute or to miss a deadline without communication.
- *Materials*: do not borrow someone else's individual supplies or equipment without first receiving permission. If you are using something that's "yours", make sure it's labeled so that it's not inadvertently borrowed.
- *Right to use shared equipment*: Return any equipment to its proper place, make sure it's clean, and keep it clear of your samples.
- *Space*: Do not leave your samples out, where they could be in the way of the work of others.

Realistic

Most of the time, the wheels of science turn ever-so-slowly. You can expect to learn a great deal about the process of science and the wonders of the earth during your research project. Your work is important and contributes to a larger body of work in geology. Not every project produces publishable results, and not every project "works". Don't let that discourage you. Even a "negative" outcome contributes to what we know – knowing what *isn't* true is just as important as knowing what *is* true.

Creative

Effective scientists are creative problem-solvers. Creativity involves resolving challenges in unique ways – scientists analyze a problem from many different perspectives in order to find a novel solution. As a student of the liberal arts, you are becoming skilled at examining a topic from multiple perspectives. As you know from classroom work, this takes practice; it's the same in the lab. Think and talk about problem solving with other geology students, other research students in Nobel, your roommate, friends, family, or anyone else who will listen. This will help you become a stronger and more flexible scientific thinker.

Honest

Science works as a scholarly endeavor because we trust that information is reported accurately and that sources are identified clearly. Our results are the only "real," tangible outcome of our work. Since so much rests on its value, it is imperative that you report them accurately and honestly. Even a lack of results can be very informative. It is sometimes difficult to decide the most accurate and objective way to conduct your work, analyze results, and interpret the meaning. **Ask**. Even if you are certain you know the answer, your thinking could be very useful to the group as a whole.

Focused

We are always busy, it seems. Whether it's the school year or the summer, it never seems to get better. If only there were more hours in the day, or you could clone yourself to get all your work done! Think of the lab (or the field) as an igloo of calm in a blizzard of activity.

Stay Engaged. Have your head and your hands "in the game." Actively follow the guidelines of this document. Listen carefully to your peers and mentors. Ask questions to clarify your understanding of a topic and to push your understanding deeper. In the words of a student researcher from years gone by, "My first year in the lab I felt very timid to ask questions because I always felt that I would come across as unintelligent and I should just innately know everything…. [It is very important] to ask questions and understand not just your own experiment, but the experiments of others in the lab. Everything is connected and you'll understand what you are doing more if you know how it relates to everyone else's project."

Practice Uni-tasking. When you begin work, set your things down and take a moment to focus on what you'll be doing today. Review your lab notebook briefly to remind yourself "where you are" in the work. Jot down what you plan to do. Then, with a clear idea of what you are setting out to accomplish, focus on one activity at a time. It is okay to have something in the oven while you're washing dishes, but do not divide your attention among activities requiring accurate or precise work. Focusing on the task at hand also means refraining from engaging in conversations while doing this kind of work. This includes telling your mentor to wait until you've finished a task if you're in the middle of something. You should avoid texting, checking e-mail, or talking on the phone while working, too. It is too easy to become distracted and mislabel a vial, pipette something twice, or misread data, ultimately resulting in inaccurate data and less-interpretable results.

Convinced that the work you do is real and matters

What you do during your research project becomes part of the legacy upon which the geology research programs and future research students depend. Think of this as a type of laboratory immortality – your geologic research spirit remains in the lab and becomes part of the work presented by the faculty and students in the geology department, long after you have graduated and moved on to do other fabulous things!

…Remember to have fun!

TEN SUGGESTIONS FOR PRODUCTIVE RESEARCH

(Distributed with permission from Dr. Pamela Kittelson)

"Creation is not an act, but a process….it is going on before our eyes." T. Dobzhansky
"…we ought generally to find the manufactory of species still in action." C. Darwin

Research is both an act and a process. Through standardized methods you attempt to discover answers to questions about the living world. You apply knowledge from classes, integrate information collected, but more importantly you will learn things about yourself and others, and you will continue to learn how to learn. Research can be wonderful as well as tedious, which means some people will love it while others do not. In the end, it does not matter if you find out research is not your gig, the experience provides opportunities to further develop abilities to think critically, communicate effectively, and even feel more deeply. The following suggestions are intended to help you develop habits that favor a successful research experience this summer as well as in other future endeavors.

1. SAFETY FIRST

Your health and that of others, including non-humans, is of paramount importance. Know weather forecasts before going into the field. Bring a weather radio on dodgy days. Wear pants and bring a loose fitting long sleeve shirt. Always wear a hat, sunscreen and solid shoes. Take a backpack with rain layers and other supplies including water, a first aid kit and bug juice or a bug net. Check for ticks, watch for poison ivy. Avoid touching eyes in the field. Do not get sunburned. Wash hands after returning from the field; shower later. Wear safety glasses and never work alone with power equipment. Try not to kill anything unless we need to (invasive species or for collection). Be aware of chemical use. No chemicals go into the microwave, which is only for food. Do not store any food, water, candy in main lab refrigerator, but you can use the mini fridge. Know where broken glass is disposed (not the trash) and be certain to clear up any broken glass promptly to prevent others from getting cut. Please let me know if you have health issues that might affect your safety (latex allergies, diabetes, insect allergies, etc.). When you work in the lab at night either have a buddy or be certain to keep the lab door locked. Know my number as well as S & S in case of emergency.

2. TAKE INITIATIVE

Taking initiative means being proactive and taking the time to think, act and problem-solve independently. Anticipate the next step(s) in your work. Next steps include both short-term daily tasks as well as the longer view. You might consider: what equipment and field guides needs to be packed for the next day, how our timeline is progressing, what experiments might be completed next and what skills are needed to complete the planned work. Identify and read relevant material, develop a sense of how to analyze data, why the questions and results are biologically relevant, and how you might talk about your work with others.

3. BE PREPARED

"In the fields of observation chance only favors the prepared mind." Louis Pasteur

To increase the probability of making an insightful observation or identifying a flawed approach learn as much as you can about what you are doing. Be proactive (see above), ask informed questions, and know what the task entails. Be prepared to make mistakes and hit roadblocks. Don't get frustrated, but have a plan B or know where to find information to help.

4. PRACTICE PERSISTENCE, TRUE GRIT

Despite preparation and hard work you will fail or achieve poor outcomes at times. Pick yourself up, face it, and deal with it proactively. Then you will be in a place to learn from it and put it behind you. The wheels of science also turn ever-so-slowly. You will get tired over different temporal scales. My mantras often are, 'just do it' or 'slow and steady wins the race.' These simple clichés have gotten me through a lot of challenging, protracted situations.

5. **CURIOSITY (ONLY KILLS CATS)**

Effective scientists are curious about the world around them. Excellent scientists think broadly, and avoid traditional disciplinary barriers. Scientists (and good liberal arts students) are creative problem-solvers capable of resolving challenges in unique ways. This requires time alone to ponder the problem from different perspectives. This also requires that you can articulate the issue to others so that they can help brainstorm solutions. Questions are not "unintelligent;" you do not innately know everything. It is important to ask questions so you understand what you are doing as well as what others are accomplishing. Everything is connected and you'll understand what you are doing more if you know how it relates.

6. **TAKE RESPONSIBILITY**

Demonstrate stewardship for our work and the lab by:

- Maintaining a well-organized, accurate and current lab notebook
- Organizing, washing and returning equipment promptly; treating equipment well
- Backing up data and turning off equipment when you are done
- Keeping your space tidy and know where your stuff is
- Alerting me when equipment is wonky or materials are low, but **not gone**.

When the inevitable happens and something breaks, runs out or needs work, tell me in person and have an idea about how you can help be a part of the solution.

7. **EXUDE RESPECT**

We work closely together day after day. Kindly respect others':

- *Time.* Arrive promptly, honor agreed upon dates and commitments.
- *Space.* This includes stuff that is yours as well as people's mental space. Keep your things together and tidy. Take calls elsewhere. Know when silence is preferred. Know when to tell a joke or defuse a tense situation. Avoid complaining about things we all are experiencing like heat or bugs. Try not to subject others to your music, especially if they are reading, writing or analyzing data (even if they say it's ok).

8. **HONESTY IS THE BEST POLICY**

Science works because we trust that results are reported accurately and sources are identified clearly. It is imperative that you report data, outcomes and other people's work accurately and honestly. Even negative results (ie. no effect) can be informative. It is sometimes difficult to decide the most accurate and objective way to design experiments or analyze data (What should I do if we have different sample sizes not randomly located? Can I throw out data if I know some plots were estimated poorly? Can I round if the p value = 0.052 and the means look different?) **Ask**. It can be an instructive experience for everyone to lay it out on the table.

9. **STAY FOCUSED, BE MINDFUL**

Have your head, heart and hands 'in the game'. Focus on one activity at a time; practice uni-tasking. Avoid having your attention divided among activities requiring accurate or precise work. Similarly, avoid careless mistakes due to the boredom induced by the repetitious nature of field work. Refrain from lengthy conversations when recording or entering data because it is too easy to make an error. Proof data entries. Review your notebook to remind yourself where you are and where you are going. Listen carefully to colleagues; reply mindfully. Give yourself time to think about results and their meaning biologically.

10. **DEVELOP CONFIDENCE THAT YOUR WORK MATTERS AND FITS INTO A LARGER PICTURE**

Your research connects ideas and people; you will become integrated into of a network of ecologists as well as into a way of thinking and being. Your research will be a foundation for others and live long after you have graduated!

Document was modified with permission from conversations with M. Bloch Qazi & former research students

KEEPING A LABORATORY JOURNAL AND A LABORATORY NOTEBOOK

(Distributed with permission from Dr. Julie Bartley)

Laboratory journals are a kind of scientific diary. In them, you record the process and outcomes of scientific investigation. Journals help you understand what you've done in the lab and serve as a record from which others can learn. The laboratory notebook is a separate binder that includes refined protocols, data analysis, and other outcomes in the laboratory.

Journal objectives

Provide a record of your laboratory activities that is clear and detailed enough to:

- offer a chronological work log that shows when and how you did your work
- present an accurate and precise record of experimental results/observations
- enable review of your notes to 'troubleshoot' aberrant results
- allow someone else to repeat your experiments and get the same (or very similar) results
- offer a clear record of your investigative process (i.e. you have a clearly-established scientific 'paper trail'). This can serve as evidence against accusations of fraud or academic dishonesty

Notebook objectives

Build on the laboratory journal to provide a record of your laboratory activities that also compiles and summarizes what you've done. It should be clear and detailed enough to:

- present an accurate and precise record of experimental results/observations
- allow someone to use a protocol that you developed or modified
- offer a clear record of what you accomplished (and what you didn't accomplish) during your research time
- summarize the results of your analysis or experiment with basic tables, graphs, and data analysis

A notebook is most useful when it is complete, detailed and legible. The journal can form the basis for reporting of results, as well as a framework for the next researcher to build upon. The following guidelines are intended to help you maximize the usefulness of your notebook and journal.

JOURNALS – GENERAL

We record notebook data in ***bound notebooks*** that are organized either by project or by researcher, depending on the particular project. Never remove pages from a lab journal. If you add a page (e.g., a typed protocol), tape the sheet into the journal, so that it can't fall out. If the pages aren't pre-numbered, number all pages.

Write in pen. Legibility and organization count! While you will have a designated journal while you work in the lab, it remains the property of the lab and will remain in the lab when you leave. The lab journal lives in the laboratory ***all the time***, and it is not permitted to spend the night anywhere except in the journal drawer (not even in the student office!). Journal pages are scanned weekly and e-mailed to your mentor, and you may scan your journal to work outside the lab, but the journal itself must remain in the laboratory.

NOTEBOOKS – GENERAL

Notebooks are ***three-ring binders*** in which you place hard copies of your research results. You will probably generate electronic files as well. These should be kept in at least two secure places (e.g., on your server drive AND on a flash drive) while you are working on the project. At the end of your project, your electronic files should be named with clear file names, and placed on a flash drive or CD, which is then placed in your laboratory notebook.

Each researcher keeps their own laboratory notebook, and a researcher working on more than one project will keep one for each project. The notebook is the property of the lab and will remain in the lab when you leave. As with the laboratory journal, you must use pen (or printed pages) and keep your notebook neat and organized.

JOURNALS – SPECIFIC GUIDELINES

Reserve the first page of the journal for a table of contents (if you're working in a pre-established journal, this element might be missing in the front; you can start one in the back). Maintain the table of contents (ToC) to help both you and others locate protocols, observations, and analyses quickly. Each page must have a date at the top. If more than one researcher is writing in a lab jurnal, your initials should also be placed in the lower right corner of each page.

For each activity (experiment, preparation, measurement), your lab journal should include the following:

- Descriptive title of the activity
- Setup of experiment
- Procedure followed – exactly as you followed it, in "real time". Record what you are doing, even if the observation doesn't seem totally relevant. These observations come in handy later when you are reflecting on the overall progress of your work. If you are following a previously established protocol, you can print out that protocol and tape it into your notebook. Carefully note any changes to or deviations from the protocol as you go.
- Record **all data**. Do not omit anything. When possible, make a table or bulleted list – this makes it easier to see and interpret later. If the data is generated by a computer, you can print it and tape it into your notebook.
- Write your impressions – what worked, what didn't? Can you draw conclusions? What more needs to be done (make a list)? It's important to do this step, too, in "real time" – at the end of each day or the end of each procedural task.

NOTEBOOKS – SPECIFIC GUIDELINES

Reserve the front of the notebook for a table of contents. Each notebook section (see below) will have its own ToC, because you'll be adding material into each section throughout your project. Divide the notebook into sections (tabbed dividers or removable sticky labels are good for this purpose), as follows:

SECTION #1

This introductory section contains your experimental rationale, a detailed experimental design, a schedule of experiments written out on calendar pages, bibliographies/relevant papers, and a copy of any proposals that were submitted for the work you're doing. (e.g., Sigma Xi proposal). This section is the "background" for your work in the lab, and most of it doesn't appear in the lab journal.

SECTION #2

Main body of work you did, referencing the laboratory journal: The journal provides a detailed diary of what you do in the lab and why you did it; the notebook compiles this into one place, on consecutive pages. You don't edit out results in the notebook, though (see discussion below about omitting data). Each activity should include:

a. **Descriptive title** of the lab activity accompanied by the **date or dates** of the activity. State the objectives of the particular activity. Repeat a shortened, descriptive title at the top of each page (you do not need to repeat the objectives).

b. **Set-up**. List materials used, equipment settings, and protocols to be followed (flow charts are often helpful here). If you have done it before, clearly reference the previous protocol and carefully note any changes you have made.

c. **Procedure**. Describe what you are doing ***as you did it***. Record what you did, even if the observation doesn't seem totally relevant. Be certain to note any amendments or deviations from the cited protocols. In some cases, this section might be scanned or copied from your laboratory journal; in others, it will be a typed-out (or rewritten) summary of what you did.

Record all data. Do not omit any data at this point. When possible, record data in tabular form. Clearly label variables measured and their units. Carefully describe what you are measuring and how it was measured. If you are collecting data, you can create data sheets on the computer, copy them, and place them in the appropriate location in your notebook.

d. **Summarize** the data in the form of a figure, if possible, and write a brief, descriptive caption summarizing the major result(s) observed and relevant inferential statistics. Do this within 1-2 days of completing the experiment. Clearly label everything.

e. **Reflect** upon the results of the activity in 1-2 paragraphs. What was accomplished by the activity? What can you conclude? What other questions have arisen? Have you met your objectives? What things might you change the next go-around? Do this as soon as (i.e. within the week after) you have finished the experiment, measurement, or observation set.

SECTION #3

Established or repeatedly-used protocols & copies of data sheet templates. These are typed and include references (i.e. where did you get the protocol). At the top of each of these protocol pages, you should include the filename where the electronic version can be found.

SECTION #4

Hard copies of all data files. On the hard copies, clearly label the filename, date, the experiment title, and the folder in which the file can be found, if it's stored on a shared computer. At this point, someone not familiar with your experiments should be able to match-up your original (raw) data, the hard (notebook) copy of your data files, and the computer copy of your data files.

If you have made a decision to omit data, clearly identify the data omitted and the reason for its omission. Scientists are very conservative about jettisoning data. The decision to do so should not be made lightly and requires a conversation with your mentor before a decision is made.

SECTION #5

Hard copies of data analyses. Generally, you will use a program (ICP-MS software, Excel, SigmaPlot, RockWare) to analyze data. Make sure that you take good care of your data analysis – save all files both to your Z drive and to another secure place (e.g., a flash drive or Google Docs site shared with your mentor). E-mailing data to yourself is NOT a safe place. Often, you will need to do your data analysis on a particular computer, rather than on your personal computer, because it's often true that formatting/version differences between computers results in incomplete files when someone else opens the file. Print double-sided hard copies of all analyses. On these copies, clearly label the filename and date, the experiment title, and the folder in which the file can be found on the computer. This too, should clearly match up with the data file from which it is derived.

Research contract: ***Student, Faculty***

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Work period ***June 4 – August 31***

This contract is a dynamic agreement that lays out goals and responsibilities for both the mentor and the student. This contract is for a grant-funded summer research experience. The student and mentor will discuss the goals and responsibilities in the contract at the beginning of the period and review them periodically. Sometimes, revision will be necessary, and such revisions will include the reason(s) for the revision and the specific activities that will assist student and mentor in accomplishing goals/measurable objectives.

Agreed upon meeting time(s):
Student and Faculty will meet twice weekly for 30 minutes, unless previously arranged to cancel or reschedule a meeting, at the following times:

Mondays at 10:00
Fridays at 3:00

Meetings will generally occur in Julie's office. Monday meetings will focus on planning for the week, and Fridays will be a debriefing and summary of the work completed during the week.

Meetings must be canceled or rescheduled at least two days in advance. Notice of cancel/reschedule should occur by e-mail. In case of a last-minute emergency, a meeting may be canceled by phone.

Communication plan:
Most correspondence will take place by e-mail. Mentors and student agree to check e-mail regularly and to respond to e-mail communication within 48 hours. If mentor or student will be out of communication for longer than 48 hours, she must give notice in advance.

Urgent or emergency communication may take place by phone. Julie can be reached at 952-479-0552, and Tara can be reached at 507-995-0859. An urgent communication is one that requires communication within the next 48 hours (e.g., cancelation of a meeting due to an unforeseen emergency). In an emergency (e.g., chemical spill or other laboratory emergency), communication should be attempted by phone first, but if contact is not immediately established, steps should be taken to handle the emergency through other means, as appropriate.

Research Goals:
The research goals this summer:

(1) To collect data relevant to the microbial taphonomy project outlined in Tara's prospectus and the Presidential Faculty-Student Collaboration Grant proposal.
(2) To develop a comprehensive literature database on the taphonomy of early eukaryotes.
(3) To investigate whether the confocal microscope is a useful tool for investigating taphonomy.

Expectations for student and faculty member:
Student is the principal researcher in this project. To accomplish project goals, she will do the following:

- Take an active role in ensuring that the laboratory is a safe place to work.
- Read sufficient literature to understand the project.
- Learn or develop the laboratory techniques needed to collect relevant data.
- Prepare samples and collect data sufficient to make a tentative conclusion (hypothesis) about the research performed.
- Keep a detailed laboratory notebook that records the work done during the summer research project.
- Make two presentations during the summer research period, as part of the Summer Research Student Program.
- Attend presentations during the summer when other students are presenting.
- Prepare or update written protocols for laboratory and instrument techniques that will be used by other researchers performing similar work.
- Present final results of summer research at the Fall Research Symposium.

Faculty will serve as mentor for this work. In order to support student in successful completion of the research, she will do the following:

- Assist Tara in understanding the relevant literature by providing key readings, discuss the overall framework of the project, and clarify points of confusion.
- Discuss safety issues and ensure that appropriate training in safe use of laboratory equipment is provided.
- Demonstrate laboratory techniques and provide training for use of equipment.
- Work with Tara in developing interpretations of data and articulating conclusions, and provide meaningful feedback and support for presentations.
- Review written protocols throughout the summer.
- Julie will keep an up-to-date schedule on Google Calendar, with indication of off-campus days.

Work expectations:

- Tara will work a total of 400 hours over the course of the summer. Specific work days and hours will be arranged in advance with Julie and will be communicated via e-mail.
- Attendance at summer research student events counts toward work hours.

Understanding of community:

All research is a community effort, and it occurs within the context of a community. As you do your research during the summer, consider the following:

- Several students and faculty members share our rather small laboratory facilities, so it is important to make the lab spaces clean and organized.
- Your work forms part of a larger effort of research, so it is crucial that you keep good notes. These notes will be used by those who work on this project or related projects after you've finished.

- Respect the samples, property, and experiments of others in the lab. Do not move or disrupt someone else's samples without consulting them first. Likewise, don't leave your samples in a place where they might be in another researcher's way.
- If you have concerns about a colleague's community choices, it is your responsibility to speak up. Communities are most effective when everyone takes a hand in making them work.
- Label all your samples, all the time. Leaving unlabeled samples out is a bad idea, even for an hour. If someone walks into your work space, they should be able to tell whose work it is and see the sample labels.
- If you break something or make a mistake, take responsibility. For minor spills and breaks, take care of it yourself and tell your mentor (and anyone else it might affect). For major problems, follow safety protocols. It may be necessary to get assistance. If you or someone else is hurt, tend the people first, then follow up with the space.
- Talk about your work with the other students and mentors in your research community. It's exciting to talk about what you're discovering, and everyone really likes to hear what's going on in the lab. Enjoy this experience!

Mentor signature: ________________________________ Date: ____________

Student signature:________________________________ Date: ____________