Lab Handbook

Lab handbook for the Zahn Lab at Utah Valley University

Lab - SB047

Office - SB243c _____ ## Contents

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01 Lab Mission

Our mission is to learn new things about the world, to help students develop as scientists and professionals to meet their educational and career goals, to be friendly, and to have fun. Most of the research that takes place in this lab is centered around trying to uncover what the heck microbes are doing, and how we can harness them to useful ends. Experiments can include field studies, manipulated experiments, observational surveys, and/or applied trials. All of this work involves bioinformatics and data analysis.

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02 Roles and Expectations

Dr. Zahn's Role:

I'm responsible for everything that goes on in our lab... my goal is to have a lab dedicated not only to uncovering new information about the world, but also to helping you succeed and achieve your academic and professional goals. Your time and effort are valuable to me and I will do my utmost to help you in your work, take your best interests to heart, and direct your efforts in ways that benefit you first and foremost. I will help you learn how research works, how to ask a question, how to get funding, how to collaborate, and how to share your results. I will invest in a friendly and pleasant working environment, with a healthy work/life balance.
_____ I'm here to help, but I'm also here to do science, so...

Your role:

You are responsible for everything *you* do in the lab. I expect you to be mature, kind to everyone, and work hard. Treat others how you would want to be treated. Enjoy the work. . . biology is awesome! ____ Here's a non-comprehensive list of things you should be doing: + Come to lab meetings prepared. + Keep the lab clean. If something is dirty, clean it up! + If you have a lab task, make sure to do it in a timely and diligent manner. + Apply for all available fellowships and grants. Take the initiative to find new ones. + Stay organized. Plan your experiments so you don't just wander around, keep track of everything in a lab notebook, try to be aware of your whole project. + It's a micro lab space. It seriously needs to be kept clean. Wipe surfaces with alcohol. All the time. Be crazy clean or all our work will suffer.

And here's a non-comprehensive list of things can can get you asked to leave the team: + Regularly missing lab meetings + Repeatedly leaving messes in the lab + Leaving the -80 freezer door unlocked and open + Harassment/bullying of other team members + Trying to hide a mistake/accident/spill/error instead of informing me or fixing it + Using supplies from other lab groups without their permission. You need something? I'll find funding and we will buy it.

Course suggestion

Learning to pipette DNA or grow fungi is one thing. Learning how to actually turn data into knowledge is another. Especially for those of you wanting to go to grad school, I'd strongly recommend learning about data analysis. I teach a course for beginners — **BIOL 3100 - Introduction to Data Analysis for Biologists** — Yes, it's self-serving that I convince you to take it, and no, you don't have to. But it's *very* useful.

Open science

I believe in open and reproducible science, and that means that at least during your time with the lab, so do you. All of our analyses are done using computer code and our raw data are shared freely at publication. If you want to be at the heart of a project from start to finish, you will need to know some basic coding skills. I recommend the R language as that is what I (and most ecologists) use.

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03 Communication

We will strive to have regular lab meetings. Sometimes these will be to practice a presentation. Sometimes, they will be to discuss methods or a journal article. You need to come to these regularly to keep me updated on your project's progress. If you have an assignment for lab meeting (e.g., a paper to read), come prepared.

All of our electronic communication is done on various Slack channels. This helps keep important announcements, etc. all in one place. If you want to share a gif of a cat riding a turtle, that is most excellent, but keep it to the *#random* channel and off of the main *#mycology* channel or your project-specific channels. I love it when cats ride turtles, and I love cool photos of mushrooms, but if I have to scroll up for 3 minutes to find the article we need to read for lab meeting, I'm gonna lose my shit.

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04 Logistics

My office is SB243c

I try to be available to you whenever I'm around in there. But sometimes my job is to sit quietly and read and write. This is how we get funding and get papers published. Send me a Slack note if you want to stop by. I usually answer those within a few minutes.

Our lab is SB047

You will need to complete Lab Safety Training in order to have keycard access to our lab. (email Craig Moore craig.moore AT uvu DOT edu to set up training) The lab area is shared with other groups. When you walk in, the room on the immediate left (with our poster on it) is our private space. The next door on the left belongs to Dr. G's lab group. The doors on the right are shared with other lab groups and have lots of equipment you can use. You know how I need you to keep our lab spotlessly clean? Well that goes double for shared spaces! Be a good citizen. + There is a key box in the main lab area. I'll give you the code to that. The key inside will open all the doors. Don't use it to open Dr. G's private lab space door. + In our lab room, there are two refrigerators. The one on the left is for sterile media, soil samples, old mushrooms, snake skins, fingernail clippings and other "dirty" and "living" things. That's all it is for. The fridge/freezer on the right is for "clean" things: extracted DNA, reagents, PCR products, MagnaBeads, etc. Keep it clean. Don't ever store live samples in there. + The main incubators in our lab (back left) are for fungal and bacterial cultures. The top incubator is divided into four shelves. Rough and dirty cultures on the bottom, going up to pure cultures ready for DNA extraction on the top. As cultures get cleaned up and isolated, they move up the shelves. + The sterile hood is really annoying sometimes, what with the beeping an such, but it's a good friend to us. Keep it clean! After every use, wipe it down with alcohol and turn on the UV light. If you want to use the sterilizer, be sure that both it and the fume hood electric power buttons are on. Don't leave the sterilizer on for more than 3 hours at a time. + If there is a bunch of dirty glassware in the sink, I'm going to lose my shit. Clean up. + The -80 freezer is out through the back door of the lab. Sometimes students will be having class in that room. That's okay, just don't be distracting to them. The freezer itself is LOCKED. **It needs to stay locked.** If you leave it open on accident it can ruin everybody's samples and reagents. If you do this, it's probably best for you to run and hide forever! + Any live cultures or pipette tips with biological material on them need to go in the biohazard trash bin next to the lab, rather than the regular trash. + Wear gloves and sterilize them with alcohol. + Follow the lab safety rules you learned in training. + Label your tubes and plates, for the love of all that is holy! + Use your lab notebook (initial and date). No matter what. It goes in the notebook... or it didn't happen.

Paychecks vs. course credit

You have a few options when you are part of this lab group: + **You can volunteer in the lab.** If you go this route, you're not earning credit or money (see below), but that doesn't mean you don't have to attend lab meetings or clean up after yourself. There's a looong list of students eager to get research experience. If you start slacking off, I'll have to let you move on and someone else will take your place. + **You can receive course credit through BIOL489R.** Up to 4 credit hours can count towards graduation. Research credit looks good on a transcript. If you want this option, just come talk with me about it and we can decide how to proceed. Keep in mind that you will receive a grade for this. Leaving messes in the lab, missing deadlines, or generally slacking off will be reflected in your grade. Also, keep in mind that 1 credit hour means working 4 hours per week minimum. + **You can get yourself paid to do lab work.** This will involve some planning ahead since we will need to write a grant. See below for resources about internal funding opportunities. I'll gladly help you write a grant for wages, but it can take a couple of months and you will need to have a solid project plan in place. This might not be the best option if you are just getting started. You can work up to 28 hours/week and earn $12/hour as a student employee, but internal grants tend to have hard limits on the maximum payout. Still, if you want to focus on research and cut down hours at another job, this will help ease your financial burden.

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05 What to Expect: A Research Project from Start to Finish

Expect this whole process to take at least a year

1. Your big idea

- So you have some biological interests. If you're here in the Zahn Lab, hopefully those interests are in alignment with the sorts of things we do.
- You'll probably start in the lab by working with a senior research student on their project, or on one of mine. This gives you a chance to get a feel for how things work and get start thinking about what sort of project you'd like to start on your own.
- I'll help you develop an idea, but it should be something you really care about. If you actually want to know the answer to a question, research won't feel like work!

2. Background reading

- Now that we've got an idea you want to work on, it's time to READ!
- I'll help point you to relevant articles, but that's just the starting point. You'll need to start "following the citation trail" of those papers and finding even more papers that relate to your question.
- The main goal at this point is to make sure your question hasn't been answered already by someone else.
- You also want to have a good understanding of your topic... enough to know what we do and, especially, what we **don't** know about your topic.
- Keep track of those papers using Zotero because you'll be citing them when it's time to write your manuscript.

3. Experimental design

- Okay, you know a fair amount about your topic and you have identified a gap in human knowledge. It's time to design a way to fill that gap.
- This is an area of science that calls for creativity. There are some rules we have to follow, but there is a lot of room to tackle your question in unique ways.
- I'll work with you to develop a plan of attack that is statistically sound, feasible, and set up to properly adress your question.
- There's a lot that goes into planning a research project.
  - What supplies will you need?
  - How much will they cost? Do you need wages covered? Travel?
  - How many samples will you need to get good statistical power? What are your controls?
  - Do we need to get collection permits or IACUC/IRB approval?
  - What's your timeline look like? How many hours a week can you spend on your project?
- Having some background in statistics will be very helpful here.

4. Getting funding

- Once your project plan is ready to go, we can apply for funding.
- We will identify a target funding program (check those deadlines!) and write the funding request.
- Then you will submit your application, get all the signatures, wait a month while stressing out, and finally get your award (think positive!)
- Once the award is issued, we can order supplies and get to work on the actual experiment.
- A lot of the hard work has been done already at this point. In the mean time, you'll be reading more papers.

5. Collecting data

- The nature of this step really depends on your project.
- You could be distributing and collecting dental swabs from dogs, monitoring soil microcosms in incubators, collecting leaves from mountains all over the state...
- But at some point, you'll probably be dealing with DNA extractions and amplifications. The details of those methods are in the protocols repository https://github.com/gzahn/Protocols.

- This part of the work gets pretty technical and requires a lot of concentration, hard work, and careful deliberation. You will get training in these skills.
- **EVERYTHING** that you do while collecting data gets written in the lab notebook and recorded in *at least two* separate digital locations. This record will not only be your raw data, but the methods section of your manuscript.

6. Analyzing data

- Here's where you'll be out of luck if you don't have a basic understanding of the R computational language.
- We need to turn all those data into pretty figures and statistical tests and use it to answer your question.
- This can take a *lot* of time as we explore your data.

7. Writing a paper

- Okay, it's been a long time since you started your project. Probably more than a year, in all honesty!
- It's time to write. I'll be setting deadlines for your writing tasks. I expect you to keep to those deadlines.
- I like to write papers in the following order, but it's not set in stone:
  - Methods
  - Results
  - Intro
  - Discussion
  - Abstract
- We will write to a specific journal format. The journal we choose for your manuscript will depend on a combination of the strength of your results, the topic, and your career goals.
- Now it's time to submit your hard work for peer review. This process is very, very long.

8. dealing with failure

- You will fail sometimes. You will drop samples. You will forget an important step in the DNA extraction protocol.
- You will forget to check on your incubations. You will run out of reagents.
- Even if everything goes really well and you try your best and are very careful and deliberate, you could ***still*** fail!
- Sometimes your data just tell you something you didn't want to hear.
- That's science. It's fine. Do your best, be careful, and follow the evidence wherever it leads.

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06 Funding

Our lab runs on hard work, but also on money. The equipment and materials we need for our projects are very expensive and so we need to be vigilant about applying for funding opportunities when they arise. Needless to say, *having a grant funded as an undergraduate student looks very good on your CV*. I expect you to apply for grants, and will do everything I can to make sure you get them.

Here are some internal UVU funding opportunities you can apply for- https://www.uvu.edu/undergrad-research/student-research/apply-for-funding/ Most of these can be used for equipment and/or wages for you. You'll have to strike a balance though. If you write one for wages but no equipment, you can't exactly do much. Better go ahead and apply to several so you can get both. Come talk to me and let's apply! If you have an idea for a different (external) grant and want to work together on it, that sounds awesome. Let's do it.

Here's an Excel-compatible yearly calendar showing approximate due dates at UVU and some conferences so you can plan out your applications: https://github.com/gzahn/Protocols/raw/master/UVU_Student_Grants_Timeline.ods

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07 Presentations and Posters

What's the point of doing science if you're not going to share your exciting results with others!? I expect that you will attend at least one conference to share your work. There are plenty of local, national, or international conferences to select from. If you want to travel to a conference, that means we need to find funding. Presntations look good in your CV, and if you are a fan of paperwork, they can mean a free or very cheap trip to somewhere cool.

- The easiest conference is UCUR https://www.uvu.edu/undergrad-research/student-research/apply-for-funding/ucur.html. It's always in-state, and funding is basically automatic if you have something to present.
- Then there's NCUR https://www.uvu.edu/undergrad-research/student-research/apply-for-funding/ncur.html. It's a national conference that's really nice, focused on undergrad research. It moves around the country year to year. if you present at UCUR first, it's easy to get funding to attend NCUR.
- Another conference I like to attend is the Mycological Association of America annual conference https://msafungi.org/meetings/. It's obviously focused on fungal biology with a nice supportive group of scientists. If you want to present at it, we need to seek funding about 5 months ahead.
- There's also the biannual International Society for Microbial Ecology conference https://www.isme-microbes.org/about that moves around the world every 2 years. It's also a good option for our research.
- You can also present here at UVU to your peers. There's always an open slot for a 15 min talk at the colloqium at the end of each semester. Good way to practice in front of a crowd and get used to public speaking in a supportive environment.
- Other conferences... if something strikes your fancy or you think it will be a good career move for you, let me know waaay ahead of time and I'll work to get funding for you to attend.

Talks vs. posters

You usually have a choice, depending on the abstract you submit and the conference to which you submit it. Talks are typically 15 minutes of hell. Posters are usually 2 hours of boredom. I'll work with you leading up to any conference to make sure you know what you're doing. You'll have feedback on your talk/poster, a chance to practice it in lab meetings, and help with designing slides/posters. I'm of the opinion that "less is more" when it comes to this stuff. We will get to that when the time comes.

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08 Publications

My goal for each student in my lab is to get authorship on a publication before they leave. This is easier said than done, but if you are willing to work and be persistent, it will happen for you. Authorship is not guaranteed, however. To be an author, you need to substantially contribute to a manuscript. That can take several forms: 1. Collecting the bulk of samples or data for a project 2. Performing data analysis and contributing toward manuscript figures 3. Writing and revising drafts of a manuscript

Each student ideally will develop their own project once they get used to lab procedures and have done the background reading in their area (I'll help you find the papers but I can't read them for you). You have initial claim to 1st authorship on any papers from your personal project. Of course, if you flake out and somebody else takes up the slack, it becomes their paper.

09 Reading List

This depends on your topic, obviously. But I'll include a partial list of some papers below that should give you a feel for the sorts of research questions and methods you'll find in our lab. Wait! holy crap, that's a lot of reading! Yeah, remember you signed up for this. Get used to it. First, read all the one's titled "Ten simple rules . . . " and then move on to the rest.

We will use Zotero to manage papers and citations https://www.zotero.org/. Look it up and learn how to use it.

- Berg, G., Rybakova, D., Grube, M., & Köberl, M. (2015). The plant microbiome explored: Implications for experimental botany. Journal of Experimental Botany, erv466.
- Bourne, P. E. (2007). Ten Simple Rules for Making Good Oral Presentations. PLoS Comput Biol, 3(4), e77. https://doi.org/10.1371/journal.pcbi.0030077
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- Broman, K. W., & Woo, K. H. (2017). Data organization in spreadsheets. The American Statistician, 0(ja), 0–0. https://doi.org/10.1080/00031305.2017.1375989
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- Huffnagle, G. B., & Noverr, M. C. (2013). The emerging world of the fungal microbiome. Trends in Microbiology, 21(7), 334–341. https://doi.org/10.1016/j.tim.2013.04.002
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- Pauvert, C., Buée, M., Laval, V., Edel-Hermann, V., Fauchery, L., Gautier, A., . . . Vacher, C. (2019). Bioinformatics matters: The accuracy of plant and soil fungal community data is highly dependent on the metabarcoding pipeline. Fungal Ecology, 41, 23–33. https://doi.org/10.1016/j.funeco.2019.03.005
- Maciá-Vicente, J. G., Ferraro, V., Burruano, S., & Lopez-Llorca, L. V. (2012). Fungal assemblages associated with roots of halophytic and non-halophytic plant species vary differentially along a salinity gradient. Microbial Ecology, 64(3), 668–679.
- Nemergut, D. R., Schmidt, S. K., Fukami, T., O'Neill, S. P., Bilinski, T. M., Stanish, L. F., . . . Ferrenberg, S. (2013). Patterns and Processes of Microbial Community Assembly. Microbiology and Molecular Biology Reviews, 77(3), 342–356. https://doi.org/10.1128/MMBR.00051-12
- Raja, H. A., Miller, A. N., Pearce, C. J., & Oberlies, N. H. (2017). Fungal Identification Using Molecular Tools: A Primer for the Natural Products Research Community. Journal of Natural Products, 80(3), 756–770. https://doi.org/10.1021/acs.jnatprod.6b01085
- Rougier, N. P., Droettboom, M., & Bourne, P. E. (2014). Ten Simple Rules for Better Figures. PLOS Computational Biology, 10(9), e1003833. https://doi.org/10.1371/journal.pcbi.1003833
- Sayres, M. A. W., Hauser, C., Sierk, M., Robic, S., Rosenwald, A. G., Smith, T. M., . . . Pauley, M. A. (2018). Bioinformatics core competencies for undergraduate life sciences education. PLOS ONE, 13(6), e0196878. https://doi.org/10.1371/journal.pone.0196878

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10 Protocols

See the separate protocols repository for these. https://github.com/gzahn/Protocols

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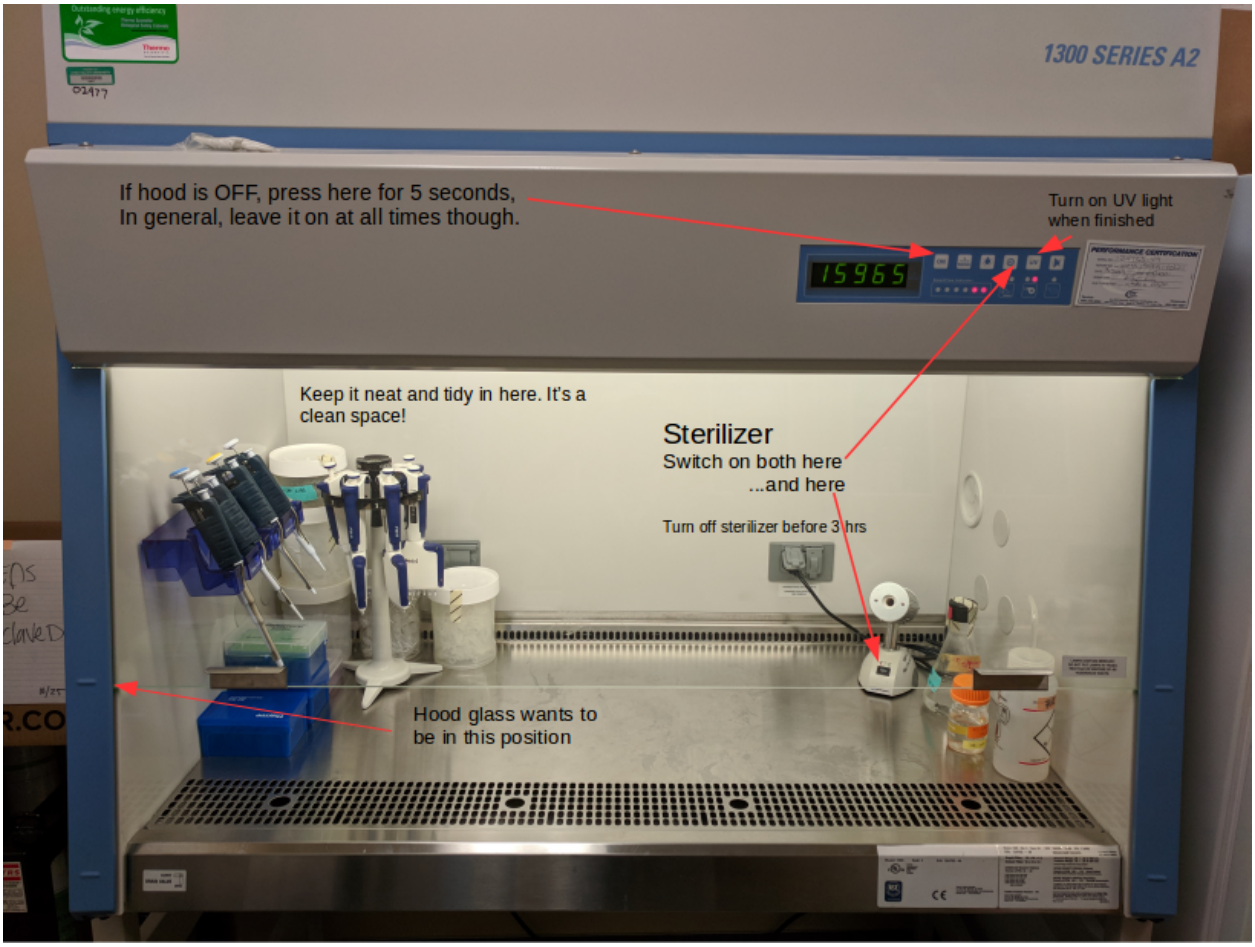
11 Lab Overview


Emergency
Eyewash/Drench Hose
Culture tools
Alcohol, bleach, cleaning stuff
Notebooks – write it down!
Tube racks, etc.
Foil, bags, misc.


World's crappiest microscope
Fungal isolate incubator
Misc. incubator
Microsopy and tubes
Reagent wells
Magnet racks
Spare parts, etc.


1300 SERIES A2
If hood is OFF, press here for 5 seconds,
In general, leave it on at all times though.
Turn on UV light
when finished
15965
Keep it neat and tidy in here. It's a
clean space!
Sterilizer
Switch on both here
...and here
Turn off sterilizer before 3 hrs
Hood glass wants to
be in this position