## Protecting animal subjects

Ethics rules protect those that are unable to protect themselves

Animal research should only be performed where justified in terms of the added benefit gained relative to the harm caused. When using animals, the experimental approaches should be selected so that they do not cause unnecessary harm or suffering. You are also ethically obligated to minimise waste and thereby reduce the number of animals that will experience harm. Be aware that poor experimental design leading to too few animals being used for you to make a meaningful interpretation of an experiment could be argued as being worse than using more animals than required. Too few animals could mean that *every* animal in the study is wasted if you don't effectively test your hypothesis. Be sure to get advice from a statistician when designing animal work.

As with human work, you must follow local rules in terms of what licences and approvals are required to be able to do your animal research. All research must follow these rules. Different countries each have distinct regulations in terms of which animals are covered but most consider all mammals, birds and fish beyond a certain developmental stage, as well as cephalopods such as octopus and squid as requiring specific approvals. Once you have approval, you must work within those restrictions, maintain records and report as required.

**Read more:**
https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm

# 3.2 Tips for Lab Life

Some tips for working in a lab-type environment, especially for those new to research.

## General tips

### Ask Questions

If you are unsure about something, ask! As a scientist, your job is to ask questions, and that overarching premise holds for general work in the lab too. The people you are working with won't expect you to know everything, or even to remember everything from the first time they tell you something, so don't be afraid to ask! You're not going to know where things are stored, how to dispose of stuff, how to use machines etc. If you are worried that you are bothering people, then ask different people each time. Many of your early questions will be able to be answered by any experienced person working in a particular lab.

For every point, there is a counterpoint. As someone who has trained lots of new researchers, the only time I get frustrated with questions is when I think my trainee is asking me *instead* of thinking for themselves. Whenever you can, it's better to say, "I think I should be doing …., is that correct?" rather than "What is it that I should be doing?"


Try to avoid questions where the answer is "have you tried looking that up"

### Set aside time to read

You'll find every aspect of being a researcher easier if you read more. Indeed, the more you read the less you'll need to bother people with questions! Try to get into the habit of reading a paper or some other information relevant to your work whenever you have a spare moment. Better still, make reading part of your daily routine; read something as you have your morning coffee or on the bus home, or whatever.

Early on you will be reading your supervisor's work and a reading list, but even once you have read those make sure you keep going! Stay up to date with new literature by setting up publication alerts on key search terms. However, don't only read the stuff directly related to your work, give yourself a strong grounding by reading work in different areas.

At the early stages of your career, you will want to build up a "tool kit" of techniques. Whenever you read a paper which uses an approach that you are unfamiliar with, take some time to read about the strengths and weaknesses of that experimental technique. Help it sink in by thinking about how you could use that approach to ask a question relevant to your work.

### Write Regularly

Get into the habit of writing often. Methods sections, review articles or literature reviews, or even public engagement pieces like blog posts are all good things that you can write without having any experimental data. Writing more frequently will improve your general writing ability and will mean that less work needs to be completed at the end.

## Becoming part of the Lab

### Respect your lab-mates, the equipment and the lab

Regardless of how much you want to work on your own, you will be dependent on others for many aspects of your work. How you interact with people will determine how they respond to you. Be understanding of their needs. Choose to be on time for meetings and appointments and let people know if you are going to be late. Be courteous in all your interactions, say please and thank you.

Respect extends beyond direct interactions; it also refers to everything about the work environment. Tidying up after yourself, and performing lab chores like stocking, cleaning, and making up communal buffers are all part of work in a research lab irrespective of your career stage. If you aren't actively helping the team, then you are hurting the lab's progress.

### Align your expectations with your supervisor's

Try to build a good relationship with your supervisor. This can be easier said than done. The answer lies in understanding what is expected of you and getting to know what you can expect from them in terms of time and interaction. Every supervisor has a different style; my advice is initially to treat your supervisor formally and follow their lead in terms of relationship development. Start by calling them Dr of Prof and only change to first names once *they* have established that it is OK. Also, address your correspondence professionally. Even once you have established a relationship, remember that they are still your boss!


Some expectations are easier to align to than others

The reverse is also true, be realistic with your expectations of what you will get from your supervisory team. If you want feedback on a draft don't expect them to drop everything to work on your manuscript. Give them time and tell them about deadlines. The more you can do to make things easier for your supervisor the more time and effort they are likely to put into helping you. Remember that your supervisor has a life outside the lab too. They might answer your email at 11.59pm one day, but you shouldn't expect them to do that every time.

One extra piece of advice; set boundaries. It is important for your mental health to have

a life away from the lab. Don't feel that you have to reply to emails etc. at all times of day and night. Take holidays and don't work every minute of every day.

A little personal note; working with my MRes, PhD and undergraduate students is a highlight of my job. I get a lot from the interactions beyond the benefit to my lab's research. I've had my share of "good" and "bad" students, but irrespective of their academic abilities it's the people and the interactions that I remember.

## Become part of the team

You are going to be working not just with the supervisor but with the entire research group. Therefore, you should do everything you can to become part of the team. As a new lab member, you are likely to be less busy than the experienced people, and you also are the person who is likely to need the most help. Therefore, foster some good feeling by pitching in whenever you can.

**Big Tip**

Research is a team sport. You aren't competing against your lab mates, you are working together toward the same goal

Also, learn what your lab mates are doing, what their experiments involve and the approaches they are taking. Doing this will help you plan your experiments and understand papers that use those techniques. Learning what else is happening in the lab will also help you learn who is the best person to ask specific questions and will ultimately make you a better scientist.

Don't be surprised if you get assigned a lab chore such as making some specific buffers, cleaning or maintaining certain equipment, and, as you get more experienced, maybe training new lab members in specific techniques. These are all normal ways to make sure the research group works at maximum efficiency. Moreover, being able to train new people is a skill that will be helpful for you in your future career.

## Attend lab meetings, journal clubs and seminars

In addition to spending time in the lab acquiring data, there will be other activities associated with lab life and which will help your personal development. Most labs will have some form of weekly meeting that will be compulsory to attend. Formats vary from group to group, but these meetings are always a good chance for everyone in the team to know what the others are doing and to catch up on lab-related news. The lab meetings primarily exist for the benefit of the researchers (i.e. you) rather than the lab head. Therefore, attending these meetings and contributing to the discussion should be one of your priorities and you should schedule your days around them.

**Big Tip**

Make the most of the training opportunities put on by your department

In addition to lab-related events, your department will likely run other opportunities to aid in your training. Seminars are great opportunities for you to learn about cutting-edge research in your field and to meet scholars from other institutions. Try to attend as many as you can from guest speakers and internal faculty, staff and students. Don't limit yourself to seminars that are directly related to your topic area. The chances are that you

could exploit the techniques being used to answer questions in your area. Even if that is not the case, you can always benefit from knowing more.

Journal clubs are another great opportunity to learn. Unlike reading papers on your own, in a journal club, you will actively critique the selected paper, looking extra carefully at the experimental specifics, data presentation and interpretation. In so doing, you will get better at critiquing your work, and this will come in helpful when writing up your manuscripts, ultimately leading to better quality outputs. Again, make time to attend and if your department doesn't yet have a journal club, think about starting one!

### Be nice to the technical team

If your research institute has technical staff that do core things such as stocking, equipment maintenance, buffer preparation, and training, then be nice to them! All the time. Their jobs are usually to make the research happen more smoothly, more easily for everyone working in the institution, but they are people too. You will need their help sometimes, and they will be much more willing and accommodating to the respectful person than the rude or overly demanding individual.

## Before you Start Your Experiments

### Be proactive about receiving training

Whenever you start a new set of experiments, you will have to be trained in some way and shown how to use specific pieces of equipment. Identify early what training you will need, who will be providing that training, and when they can do it. You almost certainly will be working to someone else's schedule for this. Get the training process started as soon as possible so that it doesn't hold you up. Follow up emails with calls, be clear about what you need and when you will need it.

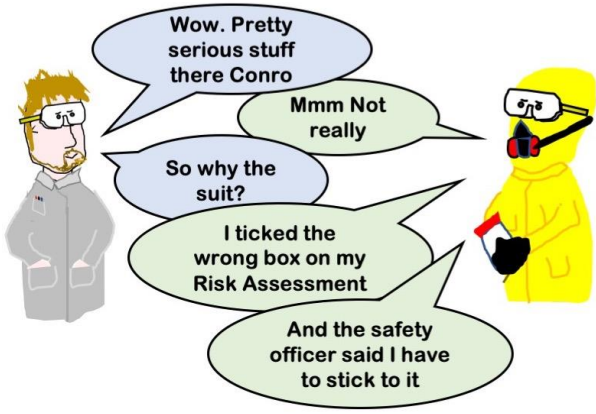
For complicated pieces of equipment such as high-end microscopes, there is no point being trained t then waiting a long time before you use the equipment. You will forget what you have learned in the intervening time. It is important to cement the knowledge you've gained. Therefore, plan the timing of your training such that you can follow up by using the kit soon after that.

**Big Tip**

Plan to use the equipment soon after you have been trained.

## Complete your safety documents: Risk assessments and COSHH

You should know what risks are associated with your work, how chemicals should be handled and how to dispose of them. Different institutions and countries have different laws, but fundamentally the advice is the same. You should know what the emergency procedures are for different chemicals or other substances in use. In the UK, the US and most of Europe this is more than just advice, it is a legal requirement. Take safety seriously. For any new chemical, record all the details you need. Pay attention to storage, protective clothing and equipment (e.g. fume hoods) required, first aid procedures and disposal procedures.




**Safety is a serious issue. Fill out your forms carefully and pay careful attention to handling and disposal requirements.**

Before you begin any work, make sure you know the evacuation procedures, first aid kit locations and what to do in an emergency.

If you are performing genetic modification, radioactive, animal or human studies you will also need to know the specific regulations governing your work, the requirements for record keeping and the different disposal routes for the contaminated samples or tissues. Falling foul of these regulations could cause revocation of licenses, and this would have a knock-on effect on other people in the group or institute.

## You don't have to invent everything: make use of lab protocols and published work

Use the experience that is around you. Most of the experiments you do will be variations on something published before. You will need to modify the protocols so that they fit the question you are asking, but fundamentally the core procedures are likely to be similar.

A related point; others will have encountered the same problem as you. The answer to your problem almost certainly is on a forum or troubleshooting page somewhere. Don't beat yourself up reinventing something, search for a solution!

# Conducting Experiments

## Read the protocol and prepare regents before you begin

Every person that trains you and every kit you purchase will tell you the same thing: read the protocol fully before you begin. While you are reading, plan your day/week with approximate timings for what you will be doing at different stages to make sure you start things and prioritise your work to be the most efficient.

**Big Tip**

Make sure, all the reagents are available and all solutions are prepared before you start.

The important thing to identify is which reagents are required. Even when you buy a pre-made kit, you often need to supply some additional materials. Make sure you have all the chemicals in stock and that you prepare any complex solutions ahead of time.

## Understand what every step of your protocol is for

You not only need to know what to do but also you should have a solid grasp of why you are doing each step. The established protocols mean that squirting the right things into the right tube in the right order will give you some data, but if you don't know what the steps are for then you may miss important pieces of information.

The biggest benefit for understanding the experiment will come if you need to troubleshoot something that isn't giving you the data you expected. If you know what is going on at each stage, you will be better able to interpret what has gone wrong and what changes to make. Understanding the protocol will also help you identify what stages can be adapted to suit your question, which parts need to be precisely controlled to minimise experimental variability and which can be adjusted to suit your available timeframe.

## Focus

As you work in the lab, you'll quickly get to the stage where you don't need to think very much about the techniques you are regularly using. However, don't get too blasé; make sure you are fully switched on, and that there are no local distractions during the times that matter. Don't be afraid to tell people to leave you alone so you can concentrate and don't disturb people who are clearly "in the zone".

Whenever you are doing something entirely new, the best plan is to reduce or remove any other experiments from your daily plan. This particularly true when it is a multi-step experiment spread over many hours. As a supervisor of a research team, I want my students and staff to generate as much data as possible. However, I would prefer you did one experiment that worked, than try to do three and made mistakes. Slow and steady will win the race.

## Standardisation

Poor quality input material can only give you poor quality data. This is a really big and important concept to take on board early. You should be critical at every stage of every experiment to make sure that you aren't introducing an experimental variable that you don't want to. Always be prepared to stop an experiment if things aren't right.

The biggest problem seen in new researchers is a lack of standardisation in the simple things which leads to loose data. Sometimes it is obvious; if you were doing a cell-based experiment and had twice as many cells per group in experiment two compared with experiment one, then you shouldn't be surprised if the outcome you are studying is different. That's a big variable that you haven't controlled. But sometimes, it is less apparent. If the cells you were using had been passaged or fed on a different schedule between your different experimental repeats, then it might not matter that you have used the same numbers in your experiment and treated them identically after that, the biological difference could still be there. It might be hard to identify these uncontrolled variables as you are actively working, so make sure that you are recording every aspect of your experiment and are careful to keep everything consistent.

The thinking that you did during your experimental design will hopefully have identified variables that you need to standardise. However, when it is a new experiment, you may not have been able to identify everything until you get into the lab and work with the real material.


**Finding key resources missing when you need them is a massive source of frustration. Keep your lab mates and yourself happy by re-ordering reagents before they run out!**

## Make sure reagents are re-ordered before they run out

One of the most annoying things is having to stop your experiments because someone has forgotten to reorder a key reagent. In practical terms, this means that you should be ordering replacements *before* things run out. This is especially true when you are using communal resources, make sure there is enough left not only for your next experiment but also for others to complete their experiments.

## Tell people when things get broken.

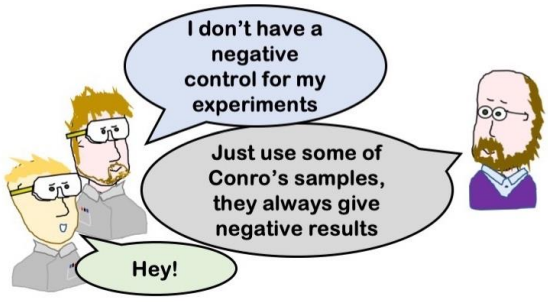
Things break, things get left out or go off, people make mistakes. This stuff happens, and we all know it. So, don't just walk away if you find a problem, do something about it. If you don't know how to fix it, then tell someone who does. If you break something, don't worry, it happens, we've all done it. It's much more annoying coming to use a piece of kit that has a problem which no one has done anything about than it is to be told about an issue and get it resolved. So, fess up and get the problem fixed.

# Dealing with Problems

## Not all your experiments will work!

Despite all your careful planning and your well-designed protocol, things will still go wrong. Your positive and negative experimental controls will help you identify where things have gone wrong, and troubleshooting guides, local expertise and online forums will help you resolve the problem. But, sometimes, none of that helps. What then?

Option one: swallow your pride and ask someone else to do it. Sometimes the fresh pair of eyes on the problem will spot a mistake, and you'll be able to move forward. Sometimes it will work for them for no apparent reason, they'll do everything exactly the same as you but for some magical reason the outcome will be better. That is frustrating, but at least you know the design was right and you will be able to move forward. Most of the time, the second researcher will come up against the same problem as you. Getting someone to help isn't a sign of failure; it's a sign that you are mature enough to realise that it is the best course for project success. It is a sign that you care more about the science you're your personal pride.




**Everybody's experiments fail sometimes. The secret is not letting the set backs get your down!**

Option two: give it a rest. You can end up too close to a problem to be able to see the solution. Focusing on a different aspect of your project for a while can help you see more clearly what has gone wrong. This can be difficult if the problem area is rate-limiting for the rest of your project, you may not have anything else you can work on. Discuss it with your supervisor and consider taking time to read or write up some other aspect of your work, or take a few days off, then come back refreshed and refocused.

On a personal note, I always found it best to have multiple experimental streams on the go at once. I would try to have something with low complexity and high success rate that would constantly yield data as well as the more difficult but probably more exciting new thing. That way, my levels of frustration at encountering problems was always tempered by having something working each week.

## Try not to compare your progress against others

I know this is almost impossible, but everybody's project is different, will progress at different rates and will run into different problems, so there is no advantage in comparing yourself to others. When things aren't going well, think about what *you* can do to move forward. Your energies are much better focused on *your* project's next small step and how *you* can get beyond your current problem than worrying about how you stack up against your peers or colleagues.

# 3.3 Time Management

### Prioritise

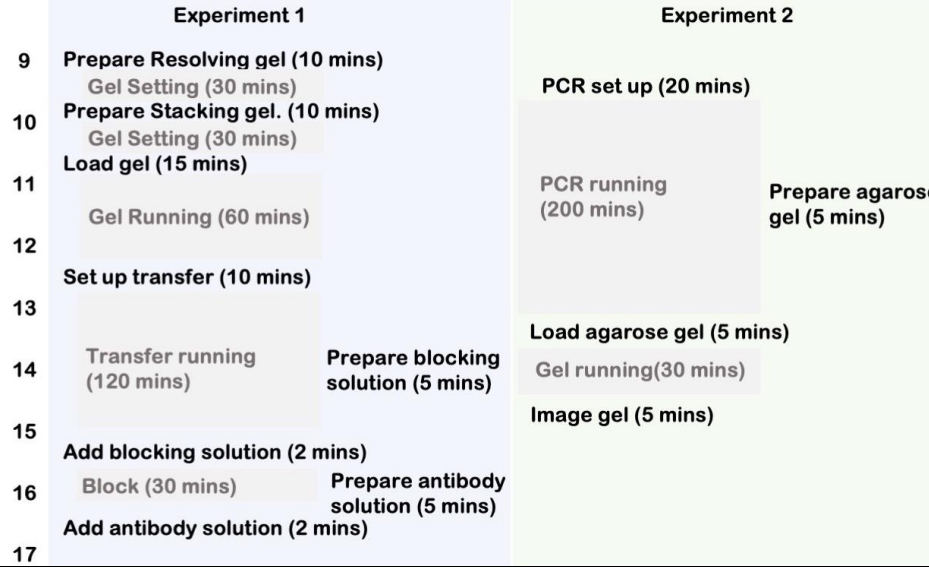
Maximising your working efficiency isn't just about an hour by hour plan to fill your day; it is also about keeping your eye on the whole project to make sure you are putting the effort into the right areas. When you are putting together short-term plans, you should do so with the project plan priority list in front of you.

### Planning your work days

Work out how long the different steps of your experiments take and plan your day around those steps. At first, it is likely that you will be doing a limited number of hands-on experiments per day, however, as you progress you will need to arrange your day so that you can complete multiple parts of your project at once. Everything takes a bit longer than you think at first, so plan in some wiggle room.

To work efficiently, you need to identify the steps that are going to take the longest and prioritise those steps; then you fit the shorter tasks around the big stuff. Sound familiar? This is the same rate-limiting step concept as for whole project planning but now looking at each part of your work days.

Almost all life science-type experiments involve an incubation step along the way where you are effectively just waiting for something to happen. The most efficient people are those who use the incubation periods of one experiment to advance some other aspect of their work. This could be writing up your methods or lab book, crunching some data, ordering reagents or it could be running one of your other experiments. It takes time to get good at this. The first step is to start thinking experiments not as the total time but rather as the hands-on time when you are physically doing something. In the example below the grey boxes are waiting times, when you could be doing something else.



### Plan time for data analysis and figure preparation.

Plan time into your week where you crunch the numbers and make draft figures. Remember, an experiment isn't finished until it's been written up. More on data analysis shortly, but for now, pilot experiments should be analysed straight away, and confirmatory studies analysed once all the experimental repeats are collected. Analysing your data might reveal interesting findings. When it does, you will want to have the time to explore those findings further. If you wait until the end to do your data analysis, then you might not be able to exploit these new exciting directions.

**Big Tip**

Your experiment isn't finished until the figure is made!
Get into the habit of analyzing data and making a mock figure before you finish for the day.

### Plan time for reading and writing into each week

I keep making this point! Ask any PhD student who has just finished what they wished they had done differently. 99% of the time they will say some variation of "I wish I had read and written more during my studies". The best way to make sure you do something is to set aside dedicated time and then get into a routine. Writing is a skill that you will improve with practice so writing more often will also mean that you produce better quality first drafts.

### Don't take on too much

As you grow in experience, you will be able to focus on more and more different things at once. However, you need to stay self-aware enough that you don't try and do too much. If you overstretch yourself, then you may end up rushing and messing up experiments. This should be obvious from your daily/weekly plan.

### Email, social media and other distractions

In our connected world, our phones are constantly buzzing with another update from emails coming in or an interesting social media post that we want to look at. The ability to resist these distractions takes discipline. An effective strategy can be to dedicate specific times to deal with emails and then saving social media for breaks or when you have gone home. Most labs will have a no phones in lab rule anyway, so you might not have an option. Like every other rule, once you get used to it, it won't feel so difficult to abide by. Personally, I turn off notifications and close my email program whenever I am doing a task that requires serious concentration.

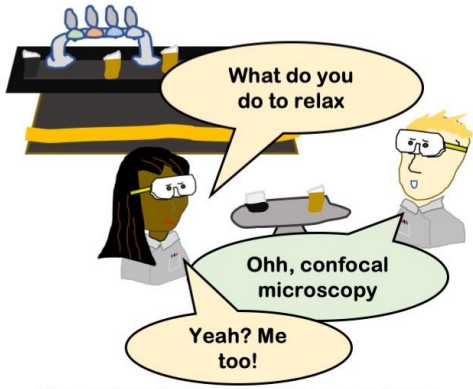
Note that there can be value to your science career to be active on social media, I'm not saying don't do it! Indeed you will find a thriving community who want to share ideas, exciting data and who can answer your questions. Promoting you own work on social media can also help it gain exposure. As with everything else, it comes down to balance and priorities.

## Work-life balance

One of the perks of our job is that we can work whenever we want (health and safety rules permitting). However, don't be surprised if your supervisor expects you to keep to a schedule. Therefore, specifically ask near the beginning of your time in the lab what working hours you are expected to keep, then stick to them. If you are working in a lab as part of a degree program, then you should also tell your supervisor what other commitments you have including up-coming exams, so that they understand absences and modify their expectations.

Some people find the lack of formal schedule to be problematic, resulting in them losing focus and starting to drift into work later and then head home earlier. Your supervisor shouldn't be asking you to work hundreds of hours a week, but they will some level of professionalism. It's totally fine to treat science like any other job.

The opposite is also true, with no specific work hours you can end up working all the time. Productivity in terms of outputs and the time you spend in the building are not directly related. Setting yourself a realistic work schedule is likely to help you focus on what needs to be completed within a certain time frame. It is important for your physical and mental health to take breaks. You will be far less productive if you are too tired or sick to work. Make sure you schedule time off and plan in physical activity.



**Regardless how much you love science, having interests outside the lab will help your physical and mental health**

Clearing your head by going for a walk or run or whatever might help form a fresh perspective to an ongoing problem. If the rest of your thinking is done while sat in front of a computer screen, then being disconnected might give a chance for uninterrupted thinking without the temptation of looking everything up.

I also strongly recommend having a mental distraction, something where you completely disconnect from thinking about science *at all* and focus on something else instead. This could be an intense physical activity or team sport, but equally could be something that requires mental focus such as art, games, dance etc.