AUDIOSCRIPT

1.1

Susana: ... and have you thought about what you'll do once the PhD is finished?

Eriko: I don't think of much else! It's actually rather scary. I know I don't want to abandon science and become an accountant, but beyond that ...

Susana: Well, let's start with a simple choice. Academia or industry?

Eriko: Oh, easy – academia. I've really enjoyed the teaching I've done, so I don't want to give that up.

Susana: But in industry you could supervise more junior researchers. You wouldn't have to give up teaching.

Eriko: No, but it's different. I find it really interesting to explain quite complex topics. Supervising people would be more practical. I really love communicating the theory side of things.

Susana: Well, yes ... but I don't think working in industry rules that out. It would just be different. You would also be out in the field more. Someone would pay you to go to real disasters to try the robots out.

Eriko: Hm. That's true. But I'm not so interested in doing that. As long as I have time to do work on developing the robots in the lab, that's fine for me. I do really want to teach though. I actually quite enjoy preparing lectures and thinking of creative ways to get the information across.

Susana: Really? OK, so assuming you go for academia ...

Eriko: I'd like to get a post-doc position first.

Susana: OK. And any idea who you'd like to work with? Or where you're looking at?

Eriko: Not really ... I'm going to leave here, though.

Susana: Oh? You don't like London? The university?

Eriko: No, I do ... but I did my Master's here, part-time, while I was working as a research assistant in the lab. And then I transferred to the PhD while still working. So, basically I've done everything here, and I really think I should change, move on.

Susana: You're quite right. Going somewhere else is a very good idea – I hadn't realised you'd been here for so many years.

Eriko: I came on a student visa nine years ago and never went back. Anyway, applications for a couple of interesing post-docs at Cambridge close early next month.

Susana: They get earlier every year! I'll look over them before you send them off, if you like.

Eriko: That'd be great. I doubt they'll want me, but I might as well give it a go. And then I'm meeting a couple of people from the University of Glasgow at the conference next month. Just for a chat.

Susana: Well, it sounds like you're doing the right things. So then you'd be looking at a full-time position in higher education after that?

Eriko: Yes.

Susana: And all the paperwork doesn't put you off?

Eriko: Well. I don't actually mind it that much. So no, it doesn't bother me.

Susana: And the money? You're not tempted by the salaries in industry?

Eriko: Not at all. Well, maybe a bit. But there are more important things than money. I know I'm not going to get rich this way. But industry work? I really don't think it's for me.

Susana: But it's good to know it's there as a possibility.

Eriko: That's true – if things don't work out ...

1.2

1 And then I'm meeting a couple of people from the University of Glasgow at the conference next month.
2 But I did my Master's here, part-time, while I was working as a research assistant in the lab.
3 But I'm not so interested in doing that.
4 But in industry you could supervise more junior researchers.
5 I find it really interesting to explain quite complex topics.
6 I'm going to leave here, though.
7 So, basically I've done everything here.
8 You would also be out in the field more.

1.3

Eriko: So if I use the research experience heading, do I include presentations, publications, grants, awards, skills and everything all in there? I mean, won't the section be too long?

Susana: You're absolutely right ... it would be too long. I think this is one of the big differences between a CV in English and the résumés most of us learned to write. In a CV you can use a lot of different headings for the various sections. So you can have a research experience heading where you list your research positions, but then separate headings for the other details, the publications and so on.

Eriko: OK, so let me just check I've got this right. I should start with a personal information heading, and then next is education. Could I just ask one thing about that?

Susana: Sure.

Eriko: In the education section, how far back should I start? I mean, which school should be first? Not elementary school, I assume.

Susana: Ah, well, another thing here. In CVs, they always write the most recent thing first. So in education, your PhD comes first, just after the title.

Eriko: So ... what ... in publications, the paper I published last is written first, right?

Susana: Right.

Eriko: Hmm, OK ...

Susana: ... and as to which education to mention, I'd start with high school at the earliest, nothing before that.

Eriko: OK, so start with Osaka University.

Susana: Exactly.

Eriko: And after the education section, research experience and then technical skills, followed by publications ...

Susana: No, no, no – put your teaching experience next, after technical skills, because you'll hopefully be doing some teaching.

Eriko: OK, so research experience, technical skills, teaching experience, publications, OK fine, and *then* grants and awards and finally presentations. Is that the lot?

Susana: Yeah, that should be good. So you'll be OK now?

1.4

Eriko: OK. Are you ready?

Carlos: Yes, yes. I am ready.

Eriko: You sure? OK? Just stop me if there's a problem.

Carlos: I will, don't worry! OK, good, go, go!

Eriko: OK then ... here it is ... Hello. My name is Eriko Oshima and I'm currently a PhD candidate at Imperial College London. My research—

Carlos: Oh! Eriko ... too fast, I think, slow down a little.

Eriko: OK, yes ... Hello. My name is Eriko Oshima and I'm currently a PhD candidate at Imperial College London. My research focuses on developing odour-sensing robots. This is useful because humans have a poor sense of smell, and so we have to rely on other methods to ...

1.5

Eriko: So how was it, Carlos?

Carlos: Well, you remembered everything, and you spoke more clearly, and not too fast, but ...

Eriko: But what?

Carlos: Well, one thing is you sound very bored. Your voice is always at the same level.

Eriko: So ... ?

Carlos: Well, if you listen to English-speaking people, they stress the important words. They make them louder and stronger.

Eriko: And their voice goes up and down more?

Carlos: Right. So try to work out which your important words are and stress them. And another thing connected to this is that you don't pause enough.

Eriko: I don't?

Carlos: Well, sometimes you do, but not always at the right time.

Eriko: So I guess I should plan when to pause too.

Carlos: That's a good idea. And there were some words you had problems with.

Eriko: Yes, it's really hard for me to say 'detect part–' ... 'detect particular' ... argh!

Carlos: So I guess you just need to practise those problem words or groups again and again.

Eriko: Argh! It's so hard!

Carlos: Why don't you ask an English speaker to record it for you? Then you can listen and try to copy them.

Eriko: That's a good idea – maybe I can ask Doug ...

1.6

Eriko: Hello. My name is Eriko Oshima and I'm currently a PhD candidate at Imperial College London. My research focuses on developing odour-sensing robots. This is useful because humans have a poor sense of smell, and so we have to rely on other methods to detect particular odours. For example, we use trained sniffer dogs to locate people trapped in buildings, chemical leaks or illegal drugs. However, there are a number of problems with using dogs. First they cannot communicate exactly what they have detected. But a robot could. Secondly, it is difficult to tell if an animal's sense of smell is in some way impaired. But a malfunctioning robot would be easily spotted. Third, animals require extensive training with ...

1.7

1 Hello. My name is ... and I'm currently ...
2 My research focuses on ...
3 This is useful because ...
4 For example, ...
5 However, there are a number of problems with ...

2.1

Ryuchi: Martina? Before I start the review I just want to check a couple of things.

Martina: Uh-huh ...

Ryuchi: So first, how long should my review be?

Martina: So, for this one, you should be able to do it in a couple of paragraphs. In the first one, start with a brief summary of the research and then go on to a second one which gives your opinion.

Ryuchi: And usually I just read the abstract, to find out about the research ... so, can I write a critical review if I've only read the abstract?

Martina: Hm, not really. I mean, in terms of the summary, you could get pretty much everything from the abstract, but it really won't help you to do a good critical review. You need to have read and understood the whole paper properly before you can judge how good it is.

Ryuchi: Hmm ... I guess that's true. So in that case, how should I approach the reading? What should I read first?

Martina: Well, of course you should read the abstract first to get a very general idea ... then focus on highlighting the key information in the Introduction, Methods, Results, and Discussion. I'd draw up a table to fill in the key points.

Ryuchi: Something like this?

Martina: Yeah, that looks great.

Ryuchi: Is it a good idea to think of questions I want answered? Like I've done here?

Martina: Yes, it's really good to have those key questions written down. They'll help to keep you focused while you're reading and note-taking.

Ryuchi: Yeah, someone else suggested I do that. And you mentioned note-taking. Do I need to take notes or can I just highlight the relevant bits of the text?

Martina: Well, you could simply highlight, but it's really important when you write the summary that it's in your own words. So if you make notes in your own words, that will help you later.

Ryuchi: Good point. And I've added this column to make notes on what I think is good and bad as I go along. To do the critique later.

Martina: Excellent idea. So why don't we ...

2.2

Ryuchi: ... So I read the paper, by Martin *et al.*, and, well, I don't think it's very credible.

Martina: OK, so can you talk me through it?

Ryuchi: OK, so, method. They studied 30 young healthy adults, and gave them 40 grammes of dark chocolate a day for 14 days.

Martina: Hmm, and do you think that's an effective sample?

Ryuchi: No, it's too small. And I also think the trial period is too short ... not long enough to get any real results.

Martina: OK, good, carry on.

Ryuchi: Another thing is that before the trial started they assessed their anxiety levels with a questionnaire.

Martina: Uh-huh.

Ryuchi: And then they divided them into high and low anxiety groups.

Martina: Uh-huh. And why might that be a problem?

Ryuchi: Well, it's a problem because it reduces sample size even more, right?

Martina: Yes, absolutely right.

Ryuchi: Then on days 1, 8 and 15 they took blood and urine samples to look for changes in cortisol and catecholamines in the urine and for differences in energy metabolism and gut microbial activities.

Martina: So what you're saying is that they didn't actually look at changes in stress levels or reported anxiety?

Ryuchi: No. They didn't. And another thing I thought was strange was that there was no control group.

Martina: There was no control group?

Ryuchi: No, so they were comparing high and low anxiety groups only.

Martina: So thinking about the discussion section – what does that tell us? Do you think they can prove it was the chocolate that caused the changes?

Ryuchi: Mmm. No, I guess they can't, really.

Martina: Good. So tell me what you think they would need to do to make this a valid study?

Ryuchi: OK, so first, they need a larger number of people with the same anxiety levels. And then, after that, they should give them either dark chocolate or a ... a ... I forgot the word. What do you call it when you tell some of the participants that you are giving them chocolate, but really, you are giving them something different?

Martina: A placebo?

Ryuchi: Ah yes, placebo. They should give them either dark chocolate or a placebo.

Martina: Yes, they should. Good.

Ryuchi: Over the long term they should look at stress levels, reported anxiety and health as well as the metabolic changes.

Martina: Good.

Ryuchi: Oh, and the researchers should *not* know which group each subject is in. So it's a blind trial.

Martina: Yes, I agree completely. So the next thing ...

2.3

Binh: ... Yes, I have that. OK, so recipient researcher? I assume that is you, rather than me.

Alina: Yes, so Dr Alina Piotrowska is fine.

Binh: And is the address OK too?

Alina: Yes, that's fine. So, the material is coming from the Liverpool Tissue Bank, good, and you're asking for breast tissue microarrays, that's fine as well, and paraffin wax embedded, *dobrze*, very good.

Binh: OK, so the rest of the form.

Alina: Well, this work is not through any industrial partners.

Binh: So that's a 'no' here? In the part about existing arrangements?

Alina: That's right ... and it doesn't have commercial potential, or you're not going to make money from it at least. They ask about that again, just here, so put no in now.

Binh: Right. Next, so, is this material hazardous? No.

Alina: Yes, yes, it is. Any human tissue is classed as hazardous.

Binh: Even when it's fixed?

Alina: Even when it's fixed.

Binh: So then does it require BioSafety Committee Approval?

Alina: Yes. But not Ethics Committee. That's only for live subjects.

Binh: Right. So yes for biosafety and no for ethics.

Alina: And we already have the BioSafety Approval ... so yes for that question.

Binh: Oh ... I don't even know what the next question means.

Alina: Oh, right ... well, one of the reasons we fill in these MTAs is so it's clear who the material and the findings belong to. In some cases, even though you do the work, as the tissue is from the Liverpool bank, they still have certain rights regarding the data.

Binh: Ah, yes, I meant to ask about that. The forms for the provider say that I have to give them my raw data when I've finished the project. Is that normal?

Alina: Yes – so the IP will be held by both us and them together.

Binh: IP?

Alina: Intellectual Property. In this case, who owns the findings in other words.

Binh: OK.

Alina: And because you are doing the work but the tissue bank wants copies of your data, we have to arrange to have a talk about what that means for you. That's why they want to know if university students are involved ... so, you can say yes here to the last question.

Binh: OK, thank you so much. Erm, Part B ...

3.1

Rayna: ... So, as I said in my email, I think we could create a material which mimics the surface of the beetle's wings and so could be used to harvest water from fog.

Bryn: Yes, that might be possible, but I don't believe it would be any better than the lotus-inspired surfaces Meera and Zein are working on. In fact, what you are proposing seems to double the work – you'd need a hydrophobic and a hydrophilic surface.

Rayna: That's true, but it seems to me that this would be more efficient.

Bryn: In what way?

Rayna: OK, as far as I'm aware, the lotus-inspired materials collect actual droplets of water, drops of rain. But this beetle seems to be able to collect water just from fog, not raindrops, so you wouldn't need actual rainfall.

Bryn: Yes, I can see that ...

Rayna: But to mimic its surface—

Bryn: Sorry, before you go any further, what use do you see for this material?

Rayna: Oh, I think it could be useful in, say, refugee camps to collect drinking water or ...

Bryn: But I can't see how it would be better than the fog-catching nets which already exist.

Rayna: Oh, well, I think nets must be less efficient because of the holes in them. Surely some of the potentially useful fog blows straight through them?

Bryn: Hmm, I suppose so.

Rayna: So a lot of water is lost. And as well as creating a material to collect water for refugees, another use might be in cooling towers, to recycle the water.

Bryn: Aha, now that sounds like a profitable use. Yes, I can see that.

Rayna: So do you have any idea how to make this material? I guess we could use microcontact printing.

Bryn: We could, but I feel there must be a simpler way than that ...

3.2

Rayna: I think we could create a material which could be used to harvest water from fog.

Bryn: Yes, that might be possible, but I don't believe it would be any better than the lotus-inspired surfaces Meera and Zein are working on.

Rayna: That's true, but it seems to me that this would be more efficient.

3.3

1 Sahal

Before I went to the meeting, I thought my listening and speaking skills were quite good, but when I got there, I realised how hard it was to listen to so many people. When you're talking one-on-one, it's easy to follow and join in the conversation. But at the meeting, the topic seemed to change before I'd had time to understand what had been said. I didn't manage to say anything at all and left totally confused.

2 Hitomi

In Japan, we let one person finish what they're saying before we start to speak. It's polite. At the first meeting I went to, everybody seemed to talk at the same time. People weren't even interrupting politely. They just talked over the top of each other. It got louder and louder. I wanted to join in, but there was no chance for me to say anything. At the next meeting, I was more confident, but it was still hard for me to speak when someone else was already talking.

3 Sam

Most meetings in my department are quite short, only about 30 to 45 minutes long, but when I first started attending, they seemed to go on for ever. I could understand for about the first 15 minutes, but after that I couldn't keep concentrating and so I would miss important information. The worst time was when someone asked my opinion and I had no idea what they'd been talking about.

4 Radek

The biggest problem I have at meetings is knowing how formal or informal my language should be. I'm not really sure which phrases are slang and things, you know. It's a real problem when I want to disagree with someone, without being rude, or when I want to ask what someone means or stuff like that.

3.4

Sarah ... so the gecko's ability to stick is basically, it's all to do with the forces between the setae and the surface.

Ali: Sorry, Sarah. Could I just ask what kind of forces?

Sarah: Well, for a while, people thought it could be capillary, but now it seems it's mainly Van der Waals forces, with just a little bit of capillary force.

Ali: Oh, OK.

Sarah: As the gecko moves, the setae are angled so that the spatulae sit flat against the surface. It seems the setae are pushed against the surface and then slid back slightly to get maximum sticking force.

Ali: Erm, sorry. Can I just check I understood? So what you're saying is that the ability of the gecko to stick is not just because of these spatulae, but because of the whole locomotor system.

Sarah: That's exactly right.

Deepak: So you're clear on the adhesion mechanism now, Ali?

Ali: Yes, I think so. Sorry, Deepak.

Deepak: That's OK. Right, so as I was saying, what I've been looking at is the effect of the geometric asymmetry of setae on their mechanical response.

Ali: Sorry, could you quickly explain that? I'm not quite sure what you mean.

Deepak: Sure. Erm ... so, at first, most of our studies of setal deformations used a single cylindrical pillar to simulate a seta. But then, of course we know from images that they're actually curved.

Ali: And don't stick straight out.

Deepak: Of course. We did look at forces with the pillar at an angle too, not just sticking out perpendicular to the surface. But what I mean is it was always straight, not curved.

Ali: OK, sorry, you were saying.

Deepak: Anyway, because we know now that they are curved, we've been comparing a curved model with the straight pillars. So, what we've found is—

Ali: Erm, could I jump in and ask a question? Why are you focusing on forces in one setae ... one seta on its own?

3.5

Deepak: So as Sarah was just saying before Ali interjected, the bottom of the gecko's foot is covered in ridges, which themselves are covered in many, many setae. The setae have flattened ends, spatulae, which when aligned correctly with the surface, allow the gecko to stick, via the Van der Waals forces we were talking about.

Ali: No, I've got that, but what I mean is, why just focus on one set–seta? It seems to me that you need more than that ...

Deepak: Of course. Well, measuring the forces of one seta, whether the adhesive or shear forces ... those are the forces ...

Ali: No, I know what they are ...

Deepak: OK, well, our analysis of the forces allows us to show the differences between asymmetric, curved pillars and straight, to show why the curved ones are more suitable for gecko adhesion. Obviously we can then scale that up to the whole animal.

3.6

Ali: Sorry, I don't think I expressed myself clearly. It seems to me that something is missing here. Surely it's important that the setae are part of a gecko.

Sarah: Deepak, I think what Ali is saying is that for the gecko to stick to the ceiling, the whole gecko has to be involved. It doesn't stick simply because its setae are curved, or because the spatulae are aligned in a particular direction. Am I right, Ali?

Ali: Yes, thanks, Sarah. Yes, what I wanted to say is that, from what I understand, the whole system needs to be working together for the gecko to stick.

Deepak: Ah yes, I see. Sorry, Ali, you're quite right. Yes, we do need to do some more work at the whole animal level, if we want to find some technological application for this research. That's one of the reasons we're trying to get someone from the zoology department to collaborate with the group. To bring that larger perspective to things.

3.7

1 Well, for a while, people thought it could be capillary, but now it seems it's mainly ...
2 So you're clear on the adhesion mechanism now, Ali?
3 That's OK. Right, so as I was saying, what I've been looking at is the effect of the geometric ...
4 Anyway, because we now know that they are curved, we've ...
5 Erm, could I jump in and ...

4.1

Dominique: Good ... so that all sounds great. You're really on track.

Silvana: Thanks.

Dominique: So I thought next maybe you could look at the adsorption of hydrogen onto some of the porous carbon materials you've been creating.

Silvana: OK, and do you have any idea about how I could do that?

Dominique: Well, I think you need to first come up with a list of the variables that could influence the uptake.

Silvana: Well, I guess what is probably most important is the porosity of the carbon fibres.

Dominique: And what would affect that?

Silvana: Well, from the work I've done so far, it seems that the temperature they were carbonised at makes a big difference to porosity – lower temperatures are better.

Dominique: OK, so one variable you could look at is carbonisation temperatures.

Silvana: So perhaps I should look at the 1273 kelvin and 973 kelvin temperatures.

Dominique: Good, so what else?

Silvana: Well, erm, actually, I'm not sure ...

Dominique: Think about how you would activate the fibres.

Silvana: Activate the fibres? Ah, OK, well, from the literature I've read it's generally the case that people have been activating them with either potassium or sodium hydroxide. So I guess that could be another variable.

Dominique: Excellent. Anything else?

Silvana: Another hydroxide?

Dominique: No, that wasn't what I was thinking of.

Silvana: Erm ...

Dominique: How much of the hydroxide did they use?

Silvana: Oh, er, I'm not sure actually. Sorry. It's been a while since I looked at the papers.

Dominique: Mmm ...

Silvana: In fact, now I think about it, I've got a feeling they might have used different ratios. I should go back and check.

Dominique: So ...

Silvana: Sorry?

Dominique: So in your next set of experiments? Variables?

Silvana: Ah ... I see, I could make different ratios of hydroxide to carbon fibres another variable. Sorry, that wasn't very clever of me, was it? So anyway perhaps I could start with looking just at a couple of different ratios, say 4 to 1 and 10 to 1.

Dominique: Excellent.

Silvana: And how about looking at different heating rates ... or the nitrogen flow rate? Should I vary those too?

Dominique: Hmm, ideally yes, but I think what's going to happen is you'll have too many variables and the results will become too difficult to analyse. You might also find it difficult to reproduce the data if you change too many factors. You might be able to just look at the papers you mentioned and see what they found to be the optimal conditions, and then try to replicate those to start with. You can always adjust them later.

Silvana: OK, I'll do that, and maybe I'll have a talk to Mauritz about the adsorption protocols he's been using.

4.2

Conversation 1

A: Right, the liquid has collected in the flask.

B: So now, you can simply use litmus paper to check that it is in fact pH neutral.

A: OK ... so ... that looks red to me ...

Conversation 2

A: And then I was going to use the geiger counter to check for radiation.

B: No, that won't work. You can't really detect gamma rays with a geiger counter. You need to use the scintillation counter for that.

A: Oh, right ... but the geiger counter is OK for measuring beta radiation, right?

B: Yes, sure. For beta radiation it's fine.

Conversation 3

A: And so we record the membrane potential at a single point on the axon through the stages.

B: And how do you do that?

A: Oh, by using an oscilloscope we can create a trace of how the voltage changes through the different phases, rising, falling and undershoot. See, it produces this arc.

Conversation 4

A: Just put the sample into the spectrometer.

B: Uh-huh ...

A: So this will measure the intensity of the blue-green light that passes through ... and that will allow you to work out the haemoglobin concentration.

B: Right. That seems pretty straightforward.

Conversation 5

A: So we could look at BMI, but instead we're measuring body fat and we're using these calipers to do that ... like this.

B: OK, so basically the distance between them is measuring the fat thickness.

A: Yeah, it's really simple.

Conversation 6

A: So you were using that piece of equipment to test the subjects' hand grip. What is it called?

B: The hand dynamometer? The one they squeeze?

A: Yeah, that one. Dynamometer? So that measures force or torque, right?

B: Yes, that's right.

Conversation 7

A: So this is a seismograph?

B: Well, actually it's a seismometer. They're both used to measure movement – motion – though.

A: So the difference is ... ?

B: Well, with a seismograph you get a drawing, a trace. The seismometer just measures ... it doesn't draw.

Conversation 8

A: So we can tell how smooth the surface is by measuring the interference pattern of the two waves of light.

B: OK, so you use the interferometer for that?

A: Right, for measuring the wavelengths and their interference when they encounter one another.

4.3

Silvana: Mauritz, do you have time to talk to me about your adsorption protocols? Dominique suggested that I talk to you.

Mauritz: Sure, just let me set this ... OK, so what is it you're going to be doing?

Silvana: OK, well, I've been working on a plan for the activation of carbon fibres. I'm going to start off with fibres which have been carbonised at two different temperatures. And then I'm going to activate each one with either potassium or sodium hydroxide, at two different ratios. And then after that I'll look at hydrogen adsorption.

Mauritz: Sounds good. OK, so first you would need to do the activation.

Silvana: Yeah. I was thinking of simply mixing the fibres with the hydroxides in pellet form, at the relevant ratios.

Mauritz: Ratios based on weight or volume?

Silvana: Oh, weight of course.

Mauritz: Just checking!

Silvana: I think the literature suggests 2 grammes of fibres with the relevant amount of hydroxide, so I think I'll try using those quantities first.

Mauritz: OK, so what ratios are you going to use?

Silvana: 4:1 and 10:1. But then they need to be heated ...

Mauritz: OK, fine. And have you thought about the set-up for that?

Silvana: Yeah, a little bit. Here's a quick sketch I made of what I was thinking of. On the inside, I thought I should have the sample on a tray in an inner tube.

Mauritz: The tray's steel?

Silvana: Mmm, yes. Or ceramic. I'm not sure yet, but I figure as long as it's unreactive it should be OK.

Mauritz: I guess, but if I were you, I'd use steel. The ceramic trays tend to be a bit bigger.

Silvana: OK, thanks. And then the inner tube is surrounded by a tube furnace, which you can see here.

Mauritz: Uh-huh.

Silvana: But I'm not sure what the tube should be made from, or even sizes for that matter.

Mauritz: I know someone who used to do something similar to this. She had a, maybe metre and a half, quartz tube, but it was quite narrow, less than 10 centimetres. I'd guess at maybe 6 to 7.5 centimetres across. Why don't you try that to start with?

Silvana: Sure. So, I'll just note those dimensions down – 1.5 metres and 10 centimetres.

Mauritz: No, I'd use less than 10 centimetres. Between 6 and 7.5.

Silvana: Oh, OK. So then the furnace needs to be linked to a temperature controller. That's up here.

Mauritz: And doesn't heating rate play a role here?

Silvana: Yes, it does. But Dominique suggested picking just one rate initially. The papers I've looked at suggest 5 kelvins a minute, up to 1025 kelvins, and then constant for an hour, so I'm planning to stick with that.

Mauritz: Hmm, personally I think slightly longer would be better. I think you should maintain the temperature for 75 minutes.

Silvana: Great. OK, so I'll go for 75 minutes at temperature.

Mauritz: And then it just cools naturally?

Silvana: I think so. I haven't included any cooling apparatus here, so I'll try relying on natural convection first, and if it doesn't work, I can add some kind of cooling mechanism later on.

Mauritz: Great. So what's this on the left?

Silvana: That's the nitrogen cylinder. There'll be a constant flow of nitrogen. I was planning on running it through at 500 mils a minute, through the entire heat treatment.

Mauritz: Well, it really sounds like you have that all worked out. It looks like it should work. And you have the washing and drying figured out?

Silvana: Yeah, again from what I've read, the best thing to do ...

4.4

Silvana: Here's a quick sketch I made of what I was thinking of. On the inside, I thought I should have the sample on a tray in an inner tube.

Mauritz: The tray's steel?

Silvana: Mmm yes. Or ceramic. I'm not sure yet, but I figure as long as it's unreactive it should be OK.

Mauritz: I guess, but if I were you, I'd use steel. The ceramic trays tend to be a bit bigger.

Silvana: OK, thanks. And then the inner tube is surrounded by a tube furnace, which you can see here.

Mauritz: Uh-huh.

Silvana: But I'm not sure what the tube should be made from, or even sizes for that matter.

Mauritz: I know someone who used to do something similar to this. She had a, maybe metre and a half, quartz tube, but it was quite narrow, less than 10 centimetres. I'd guess at maybe 6 to 7.5 centimetres across. Why don't you try that to start with?

Silvana: Sure. So, I'll just note those dimensions down – 1.5 metres and 10 centimetres.

Mauritz: No, I'd use less than 10 centimetres. Between 6 and 7.5.

Silvana: Oh, OK. So then the furnace needs to be linked to a temperature controller. That's up here.

Mauritz: And doesn't heating rate play a role here?

Silvana: Yes, it does. But Dominique suggested picking just one rate initially. The papers I've looked at suggest 5 kelvins a minute, up to 1025 kelvins, and then constant for an hour, so I'm planning to stick with that.

Mauritz: Hmm, personally I think slightly longer would be better. I think you should maintain the temperature for 75 minutes.

Silvana: Great. OK, so I'll go for 75 minutes at temperature.

Mauritz: And then it just ...

4.5

Silvana: ... I've done a bit more reading, going back to some papers I read at the start and looking a bit more at the detail, and I've had a talk to Mauritz, and to Padma, about the protocols, so I think I'm basically ready to go now.

Dominique: OK, so let's talk through what you think might happen, from what you've read.

Silvana: Well ...

Dominique: Start with what you know best, the carbonisation temperatures.

Silvana: OK, so from what I've been doing, I know that carbonisation temperature has an effect on porosity.

Dominique: Uh-huh ...

Silvana: And so if lower temperatures increase porosity, the fibres which are carbonised at lower temperatures will probably adsorb more hydrogen.

Dominique: That makes sense. So the next variable was going to be which hydroxide you use. Any idea what will happen there?

Silvana: Well, I really don't expect there to be any difference between the sodium and potassium hydroxides.

Dominique: Oh ...

Silvana: Well, I mean, I don't know that, it's just a guess, but I don't expect a difference because they both seem to be pretty good activators from what I've read. Saying that though, I haven't found any literature which compares the two directly. I'm actually really interested to see if there is a difference.

Dominique: Yes, that should be interesting. And the ratios?

Silvana: Hmm, well, my prediction is that the higher ratio will lead to better activation of the fibres and I think better activation will allow more adsorption. But actually, I've been thinking about this a lot and I'm wondering if I should do a wider variety of ratios – maybe add in a 6 to 1, giving three variables there. What do you think?

Dominique: I can see how it would be useful, but I think to start with you should concentrate on just the two, while you perfect the method, and then you can fill in the gaps later.

Silvana: OK, I'll stick with just the two for a start.

Dominique: And hopefully you'll have some data ready for when I get back from my trip. We can meet again then to look at it.

5.1

Chuyu: ... I've just finished writing it, so could you look at it before I show Lucia?

Thabo: Of course. So it's a summary of the way the multi-anvil works?

Chuyu: Kind of. It's the process I use to measure the mineral strength, so yes, including the multi-anvil.

Thabo: Right. OK. Well, the first thing I can see is that you need to make sure you use linking words, to make your stages clear.

Chuyu: Do you mean things like firstly, secondly? Well that should be easy enough.

Thabo: Yes, some of those, but also things like 'then', 'after that' and all those kinds of sequence words.

Chuyu: Right, OK.

Thabo: Not too many, though. And you might find that when you do that your sentences seem a little short, and the language could be a bit repetitive.

Chuyu: So I need to find other words to say the same thing?

Thabo: Well, you could do, but I was thinking more that you will need to combine sentences.

Chuyu: Can you give me an example?

Thabo: Mmm. So here, in the second and third sentences, you've got 'The powdered mineral sample was placed into a tube of rolled rhenium. The rhenium tube was loaded into a ceramic octahedron.'

Chuyu: Yes ...

Thabo: So it would be better to say '*First* ... the powdered mineral sample was placed into a tube of rolled rhenium, *which* was *then* loaded into a ceramic octahedron.'

Chuyu: Ah, I see. So this one would be ...

5.2

Thabo: Well, you could do, but I was thinking more that you will need to combine sentences.

Chuyu: Can you give me an example?

Thabo: Mmm. So here, in the second and third sentences, you've got 'The powdered mineral sample was placed into a tube of rolled rhenium. The rhenium tube was loaded into a ceramic octahedron.'

Chuyu: Yes ...

Thabo: So it would be better to say '*First* ... the powdered mineral sample was placed into a tube of rolled rhenium, *which* was *then* loaded into a ceramic octahedron.'

Chuyu: Ah, I see. So this one would be ...

5.3

Chuyu: So let me tell you about my results, and then we can have a look at yours.

Lucia: So what did you find?

Chuyu: Well. so far. I've looked at the upper mantle olivine and the lower mantle perovskite. And then I've also done a couple of runs with wadsleyite and ringwoodite from the transition zone, but I'm having some issues ... I'm getting weird and inconsistent results.

Lucia: Well tell me about the ones you're happy with for a start, and then we can try to work out what's going on with the others. So?

Chuyu: Right, well, firstly I thought that the differential stress in all of the samples would go up as the pressure increased ... and it *did* for olivine and for perovskite. In fact, there was a clear linear relationship until the sample yielded. Then it reached a plateau.

Lucia: So the differential stress after that is actually the yield strength of the sample.

Chuyu: Right. And, as I expected, the perovskite was the strongest. It yielded later than olivine.

Lucia: Uh-huh.

Chuyu: But what was really interesting though was when the samples were also heated.

Lucia: In what way?

Chuyu: OK, well, I expected that increasing the temperature would reduce yield strength.

Lucia: So the mineral would yield at a lower pressure if the temperature increased?

Chuyu: Right. And that's what did happen with the olivine. In fact, its strength went right down as the temperature went up.

Lucia: By how much?

Chuyu: Well, when the pressure was maintained at 10 gigapascals, increasing the temperature to 873 kelvins reduced the yield strength to less than a fifth of what it was at ambient temperature.

Lucia: A fifth? Wow, that's pretty amazing.

Chuyu: Yes, but possibly more surprising was that the perovskite seemed resistant to temperature. Even increasing the temperature at high pressure didn't reduce yield strength.

Lucia: Really? I thought the minerals would all be affected by temperature. I mean to some degree, at least.

Chuyu: Well that's what I expected too, but it seems I was wrong ...

5.4

Lucia: Really? I thought the minerals would all be affected by temperature. I mean to some degree, at least.

Chuyu: Well that's what I expected too, but it seems I was wrong. I guess there are a couple of possibilities. The first is that the sample needs to be heated to an even higher temperature ... I've gone up to 873 kelvins but perhaps what I need to do in the next run is increase the temperature even more. I can get it up to 1073 kelvins without any trouble but I'm not sure I can go any further.

Lucia: Uh-huh.

Chuyu: Another possibility is that the pressure needs to increase. Perhaps with a higher pressure, temperature would have an effect.

Lucia: But you can't get it any higher, can you?

Chuyu: I can, but I would need to use the Diamond-anvil cell to do that.

Lucia: OK. And is there another possibility?

Chuyu: Yes, that this is a real result. I've run the experiment numerous times with a few different samples and the results I'm getting really do seem to suggest that the yield strength of perovskite is unresponsive to temperature.

5.5

Chuyu: But then the ringwoodite. It's a transition zone mineral, so I expect it to act like wadsleyite.

Lucia: So again, kind of halfway between olivine and perovskite?

Chuyu: Mmm. But it's causing me no end of problems. I mean, I haven't done much with it, but so far the results are all over the place. Look.

Lucia: Mmm, I see what you mean. That doesn't look too good.

Chuyu: Not too good? It's a disaster!

Lucia: So what do you think is going wrong?

Chuyu: Well, I've got a couple of ideas.

Lucia: Yes?

Chuyu: Well, firstly, the samples I've been using might not be ringwoodite at all.

Lucia: How so?

Chuyu: Well, look at this set of results.

Lucia: Hmm. It looks like you're using olivine again. Could the samples have been switched by accident, maybe?

Chuyu: Well, maybe. But I doubt it's olivine. But it could be something else very similar. Forsterite, maybe?

Lucia: Yeah, it's possible. But I really think it's unlikely.

Chuyu: Yeah, I do too. But I've sent it off for a composition analysis anyway. Just to rule it out. So my second idea is—

Lucia: Hang on. I'm sure I remember Thabo talking about strange results just like this a few months ago. He reckoned the machine needed recalibrating. Maybe that's the problem.

Chuyu: Mmm, yes, I guess if my measurements aren't coming from the same base point then there could be problems. But I'm sure there were technicians here just a couple of weeks ago checking and adjusting it.

Lucia: You could be right. It was just a thought.

Chuyu: Mmm. But actually, now you mention it, a calibration issue is a possibility. I have to admit that I'm not the most careful about properly recalibrating between runs. I mean, I usually reset and adjust it before I start a series, but I don't always do it between every sample. I kind of figure it shouldn't get too far from standard.

Lucia: Chuyu!

Chuyu: Yeah, now you mention it ...

5.6

A: So to assess the reaction to CO_2, I used 5 miligrams of char in the TGA pan.

B: Uh-huh, and the same heating rate as last time?

A: No, this time I heated it from room temperature to 378 kelvins.

B: Sorry, let me jot that down. Room temp. to 378 kelvins.

A: Yeah, and then held for 30 minutes.

B: 30? So that's a change from last time. It was just 20 minutes before.

A: That's right. OK, so then I heated at 20 kelvins a minute to 873 kelvins and then reduced it to 7 kelvins a minute to 1473 kelvins.

B: Great, so 20 kelvins a minute then down to 7 kelvins a minute. And the gas you used?

A: Well, it was a mixture of high purity CO_2 and nitrogen.

B: And the CO_2 concentration?

A: Oh, erm, 25% I think ... let me check ... yeah, 25%.

5.7

Chuyu: So, Mayumi, I've been thinking about switching to an e-notebook, but I've never seen anyone use one. How is it?

Mayumi: Oh, it's so much easier. But really? People here don't use them? I had to use one in my last lab, for the security. It's excellent. You should try one.

Chuyu: Ah yes. That was a commercial lab, wasn't it? I'm not surprised that the security was much tighter there.

Mayumi: But it would work really well here, too. If you have e-notebooks, everyone can share their information so easily. You don't have any problems trying to read someone else's notes.

Chuyu: Yes, and I guess you can also share things with people in other labs instantly, instead of waiting for meetings ... or to write something up.

Mayumi: Yes, it's even better than sending an email because they can see everything all at once – the protocols, all the data, images, everything is there together. And another thing that's really great is that you can search your own lab book, and also if you refer to a particular compound or reagent, you can link to its details on the web. You don't have to note all its details down yourself.

Chuyu: Yes, and you don't need to worry about rules for crossing things out or leaving empty spaces or being sure to date everything. I assume that's all done automatically, you know, like the highlighting of the changes you've made?

Mayumi: That's right.

Chuyu: It sounds great in theory ... but I guess the packages are set up in one particular way. It might not really be good for the research you're doing.

Mayumi: Well, that's true, but in most cases you can customise the book to your group's specifications ... although that's a bit more of a problem here than it was in my last lab.

Chuyu: Hmm. But from a security point of view, it's just so much safer. There's no risk of leaving your lab book on the train.

Mayumi: When we were using paper books, we were never allowed to take them out of the lab ... ever. In fact, they couldn't even be left on your desk at night. They had to go into a safe.

Chuyu: Mmm, I guess security really was much tighter there.

5.8

1 I had to use one in my last lab, for the security.
2 You should try one.
3 If you have e-notebooks, everyone can share their information so easily.
4 You don't need to worry about rules for crossing things out.
5 When we were using paper books, we were never allowed to take them out of the lab ... ever.

6.1

Kimiko: Hi, Tom. Do you have a moment?

Tom: Sure, Kimiko. What can I do for you?

Kimiko: Erm ... I'm just trying to write up my paper and, erm, I wondered if you could look through it for me?

Tom: Sure. I've got a bit of time now, as it goes. Was there anything in particular you wanted me to look at?

Kimiko: Not really. It's my first draft, so just any advice you could give me would be really helpful.

Tom: Sure. Let's have a look then. Well, the diagram's nice and clear.

Kimiko: Really? Oh, thanks.

Tom: But first of all you need to explain briefly what's happening, what you did, in each stage.

Kimiko: Is the diagram not clear enough?

Tom: The diagram's much clearer if you know something about the process. But not everyone who reads this paper will, so you should definitely include a short description.

Kimiko: OK. I'd better do that, then.

Tom: Why don't you talk me through it and make some notes as you go? Then you can write it up properly later.

Kimiko: Thanks, Tom. So, the basic idea is that we can use carbon nanotubes, CNTs, to send a drug right to where it's needed. That's why some people call it a 'magic bullet'.

Tom: Uh-huh.

Kimiko: To do this, first we coat the surface of the tube with a chemical receptor. For instance, if we want to target a tumour which overexpresses folic acid, then we attach folate receptors to the surface of the nanotube.

Tom: Because folate receptors bind to folic acid?

Kimiko: Yes. And then we encapsulate the drug in the tube. This is the part I'm most interested in. Up to now, a lot of different methods to get things into the cell have been tried, but I'm looking at just one of them in my paper. OK, so if you look here at the first part of the diagram ... once the drug is encapsulated, we use a cap to close the open end so the drug can't escape.

Tom: And that's when we take the capsules?

Kimiko: Yes. You can swallow them or you could have them injected, or even inhaled.

Tom: OK. So then they're in the body, shooting to the target?

Kimiko: Uh-huh, and if they're properly functionalised, they should arrive. After that, the capsule is internalised by the cell.

Tom: And how does that happen?

Kimiko: Through receptor-mediated endocytosis. Then the tube opens up in order to let the drug out. There are different ways of doing this, but I use biodegradable caps. The cap dissolves and then ...

Tom: And then the drug can start doing its work?

Kimiko: Exactly ... it's released from the tube and starts to act.

Tom: Well, that sounds fine so far, Kimiko. If I were you, I'd write that up first.

Kimiko: And then can I get you to look at the rest?

Tom: Sure, no problem.

Kimiko: Thanks, Tom. I'll see you later.

6.2

1 To do this, first we coat the surface of the tube with a chemical receptor.
2 If we want to target a tumour which overexpresses folic acid, then we attach folate receptors to the surface of the nanotube.
3 And then we encapsulate the drug in the tube.
4 Once the drug is encapsulated, we use a cap to close the open end so the drug can't escape.
5 After that, the capsule is internalised by the cell.
6 I use biodegradable caps. The cap dissolves and then ...

6.3

Tom: OK, so—

Kimiko: Oh my goodness! Look at all that underlining! My English is so terrible!

Tom: Oh Kimiko! No, no, it's fine! Really!

Kimiko: But ...

Tom: I was looking at style, rather than grammar, the grammar's fine. Just look at all the parts I *haven't* underlined! Look, this first sentence is really nice. It gives a really good overview of the aim of the whole process.

Kimiko: OK ...

Tom: OK, so, style: like here I noticed that you've used too many sequencing words. It's OK to use some but you've got firstly, secondly ... even fifth. I used to do the same thing. It's better to just write in order and only use words like 'then' when you really need to. You'll get more natural at it in time. So I'd cut all those words if I were you.

Kimiko: Maybe as I read more papers I'll write better.

Tom: Definitely, definitely. OK, the next thing is that you've said 'I functionalise the surface'. Remember to keep the writing objective. It shouldn't matter who does the experiment, the result should be the same. So don't use 'I' or 'We' in your write-up.

Kimiko: So what should I say instead?

Tom: Use passives instead. So here 'The surface of the nanotubes *is* functionalised'. You see what I mean about style? Actually, there is just one, literally one, grammar mistake though. You've said '*for* target a tumour which da-da-da' but it should be '*to* target'. You use '*to*' and the verb to say *why* you do something.

Kimiko: Oh!

Tom: Hey, come on – one mistake is really pretty good.

Kimiko: I guess. What about this one? It should say 'the drug molecules *were* encapsulated' not 'I encapsulated', right?

Tom: Erm, where are we? Oh yes. Yes, yes, it should be passive. But it should also be in the *present* tense, not the past.

Kimiko: But why? I thought when I talked about an experiment I'd done, I should use the past.

Tom: Well, that's true, but here you're talking about the process in *general*. It's not about one particular experiment you've done.

Kimiko: Right. So, the general process is in the present, but when I go on to focus on my experiments, on filling the nanotubes, I should use the past.

Tom: Exactly right. Like here, 'the nanotubes are ingested'. I'd take out this sentence though – the examples of the ways to ingest the tubes. I mean it's true, but it's not really relevant to the focus of your research. Never include information the reader doesn't need to understand your work. Even if it's interesting.

Kimiko: OK. Then this next sentence should be passive, I guess. 'The target site is located by the nanotube'.

Tom: Well, actually, no. Your original sentence is fine. Some verbs can have a non-human subject, so you don't need to use passive. Like 'locate to' here, or 'internalises' in the next sentence. 'The target cell internalises the nanotube' is completely fine.

Kimiko: Er ... so why have you underlined it?

Tom: Well, it's fine if you're talking about target cells. But in your text you've been talking about nanotubes all the time, so that should be your subject.

Kimiko: So I should use passive, then? To bring 'nanotubes' to the beginning of the sentence.

Tom: Exactly.

Kimiko: OK, and this last one should be 'the nanotube is internalised by da-da-da'?

Tom: Ha-ha! Right! So anyway let's have a look ...

6.4

1 As this was a dosage of 0.166 miligrams of fluoride per kilogram body weight, the equivalent amount needed to achieve a similar peak in a 20 kilogram child would be 3.33 miligrams of fluoride.
2 The sensitivity of the assay was 0.2 picomoles.
3 The output impedance is about 0.02 ohms at the 5 volt end and 0.1 ohm at the 15 volt end of the range.
4 Six-amp three-core mains flex is used for the mains input which connects straight to the p.c.b.
5 Inserting a few atoms of potassium makes the compound a superconductor which, below a critical temperature of about 19 kelvins, conducts electricity with no resistance.
6 This shows that where two moles of hydrogen gas combine with one mole of oxygen gas to form two moles of liquid water, at a pressure of one atmosphere and a temperature of 298 kelvins, the enthalpy change is minus 571.6 kilojoules.
7 Isolated young mice squeak repeatedly at frequencies of 45 kilohertz to 88 kilohertz, until their mother comes and returns them to the nest.
8 In a similar form of these experiments, conventional, 50-nanosecond laser pulses were used.

6.5

a A quarter
b Fifteen percent
c One point three five six
d Two million, nine hundred and five thousand, seven hundred and forty
e Five times ten to the nine
f Minus thirty-five
g Ten to the power of six
h Ten thousand, eight hundred and ninety-three
i Minus fifty-seven
j Seventeen and five eighths
k Nought point nought nought three
l Five million, ninety thousand and nineteen

6.6

1

a three quarters
b five eighths
c four ninths
d ten to the power of seven
e ten to the power of minus nine

2

a per cent
b times
c minus

3

one point three five six ... one thousand, three hundred and fifty-six

6.7

Arnie: So, you were more successful this time, Kimiko. Run me through what you did. And particularly what you did differently.

Kimiko: So, this time I think the tubes I used were more consistent in size. 20–50 micrometres in length, with an average diameter of 500 nanometres and the wall thickness was—

Arnie: Ah, sorry, if we could just go back a moment. The average diameter was 500 nanometres. So what was the range exactly?

Kimiko: The range, yes, uh, the EM images showed them being between 300 and 700 nanometres, but sometimes the tubes get deformed so they might have been slightly narrower than that.

Arnie: Hmm. See if you can get that even more standardised next time, if possible.

Kimiko: OK. I'll just make a note of that.

Arnie: And the wall thickness?

Kimiko: Erm ... on the 29th it was 20 nanometres, but this time it was a bit less, at 15 nanometres.

Arnie: Right, so last time you had problems getting the tubes onto the slides. That went better this time?

Kimiko: Yes, much. I suspended the tubes in the 2-propanol and then used dielectrophoresis to get them onto the slide. The 2-propanol just dries away.

Arnie: And that worked?

Kimiko: Yes, really well.

Arnie: OK, so we don't need to change anything there.

Kimiko: No, not at all. So after that, just like last time, I put a drop of the beads suspended in ethylene glycol at one end of the tube. The beads were the same as before – 50-nanometre diameter – but this time I used 1 to 3 beads to liquid instead of 1 to 1 like last time.

Arnie: Aha!

Kimiko: And this time I used the glass micropipette, as you suggested ... and then I dipped the end of the tube in the drop and it just filled the tube. Just by capillary action.

Arnie: So we were right. It can be done that way.

Kimiko: It seems so. And after the liquid evaporated, we had plenty of beads still in the tube.

Arnie: Great. So what now?

Kimiko: Well, I think that the overall length of the tube maybe affects the filling rate, and it might also depend how much of the tube is in the solution. I'm not sure, but I guess ideally I'd look at that next.

Arnie: That sounds like a good idea. Let me know how you get on.

7.1

Nour: So what is it that you work on, Tiago? Océane didn't really explain to me.

Tiago: Oh, right. Well, I'm looking at how shrimp have adapted to the hydrothermal vent environment. To the high temperatures and the metal concentrations.

Nour: Shrimp. Right. And what are you measuring? I mean, how do they adapt?

Tiago: Oh, so I've been looking at metallothionein levels.

Nour: And they are the metal-binding proteins, right?

Tiago: Yes, exactly. So I'm expecting vent shrimp to show higher levels, to be able to deal with the high concentrations. Oh, I should have said, I'm comparing two vent species from the Rainbow field and two lagoon species from the Rio Formosa lagoon. They're, like, my control.

Nour: Right. And are you looking at antioxidants as well? They're usually important, aren't they?

Tiago: Yes, yes I am. Four different types of antioxidant enzyme.

Nour: And how is it going? What are your results looking like?

Tiago: Oh, well, I've collected quite a lot of raw data and I've just started doing my analysis. But I'm getting some interesting results. Anyway, what is it you're focusing on, Nour?

7.2

Océane: OK, so let's have a look at these charts.

Tiago: Which do you want to start with? There are a lot.

Océane: Well, as they're all bar charts so far, let's look at the MT one first and then any changes we make to it can probably be made on the others too, I expect.

Tiago: OK, here it is.

Océane: Right, so your scale is good, the chart looks a good size.

Tiago: And for the antioxidant levels, is it OK to have different scales?

Océane: Yes, of course. Imagine how it would look otherwise. Right, but what you haven't done is label your axes. You need to do that.

Tiago: So just with what it measures? MT levels on the y-axis and the location on the x, or do I need the species?

Océane: Hang on. Remember that the units for the MT levels also need to be included.

Tiago: So I need to say the MT level, milligrams per gram of protein?

Océane: Right. If that's what your unit is.

Tiago: Yeah.

Océane: Now, the shading you have used is good. It'll reproduce well in print.

Tiago: And I've made sure they're consistent across all the graphs.

Océane: Great. But you do need to have a key, to show what your colours mean. I know you've put that in the caption, but a key is essential all the same.

Tiago: OK, that's not a problem. I'll add a key to each one.

Océane: OK, something else you need to add to your charts is an indication of your standard deviation. I assume what you've plotted is the mean?

Tiago: Yes. So I should add those 'T's on top of the bars?

Océane: Yes, that's certainly one effective way of doing it. And you've already highlighted those results that are not statistically significant. That's great, Tiago.

Tiago: Thanks.

Océane: Just make sure you mention that that's what it shows in the caption.

Tiago: OK, I will. And while we're on the subject of captions ...

7.3

Nour: So Océane, there's something I don't understand. Why do I need to write descriptions of my charts in the results section if they can stand alone?

Océane: That's true, they do stand alone. But the text highlights the *key* results. A chart might show a few different things; the text points out which are the most important.

Nour: OK, that makes sense. And another thing, what about results I wasn't expecting? If I have negative results, should I include those?

Océane: Definitely, I mean, they're an important part of finding the answer to your questions.

Nour: Right, well I have a couple of those. So then do I need to say what the results mean here? Or is that in the discussion?

Océane: No, no, no. In this section, you should just highlight the main trends of key differences. Any interpretation comes in the discussion section, as you said.

Nour: Good, that's what I thought. OK, so in the results section, do I need to put in every table or chart that I've produced?

Océane: No, because some of your charts will not really show anything of interest. Look, what I would do is this. First, take all your charts and choose which ones show important findings. Then, decide which order you should describe them in to present your results logically.

Nour: OK, so choose them, then order them. And number them then?

Océane: Yes. Remember – tables and figures are numbered separately.

Nour: Yeah.

Océane: While you're working out the order, make a note of what the key results depicted in the charts are. Look at getting a couple of points for each chart. They're what you talk about in the results section.

Nour: OK, so do I need to write about all the visuals I include in the paper?

Océane: Yes. Any table or graph which is shown in the paper also needs an explanation in the text of the results section.

Nour: Right. And in the same order they're numbered too, I guess?

Océane: Yes.

Nour: So this might be a silly question, but what kind of things are key results?

Océane: Well, in general, you're looking at things that are interesting because they're similar, or because they're different. You might have values that are very high or low ... or interesting correlations.

Nour: Hmm, right ... and then when I'm describing a figure, do I need to mention every value?

Océane: Absolutely not. As I said, make notes on the key results only. Another thing to remember is that you shouldn't include raw numbers. You can talk about means, about percentages, that's OK, and remember to include units. People sometimes forget.

Nour: And should I include my statistics?

Océane: Well, one mistake people often make is to use whole sentences to talk about the statistics. What you should do is put the test name and the p-value in parentheses after the result.

8.1

Max: OK, so what I'm trying to do is to dope graphene to make it more useful for electronics.

Florence: Right, so when we dope silicon we add boron, phosphorus, something like that, actually into the crystal structure to change its properties. Are you doing the same?

Max: Well, yes and no. I mean, of course I'm adding something to try to change its properties.

Florence: But?

Max: But because the graphene is really just an ultra-thin layer of carbon, I'm trying to just put the dopant onto the sheet.

Florence: And you're using ... ?

Max: Well, I've tried gold and nitrogen dioxide, but I've only had mixed results. So recently I've been working with F4-TCNQ.

Florence: Ah, right.

Max: So really I've been trying to work out a couple of things. First, I just needed to see if doping graphene with F4-TCNQ could neutralise the excess negative charge.

Florence: Mmm ...

Max: I mean, it certainly seemed theoretically and experimentally possible, but it hadn't been done.

Florence: And it worked?

Max: Yeah, it seems to have. I'll let you have a look at some of the data to see what you think.

Florence: Sure! That'd be great. And did you look at the stability of the dopant?

Max: Yeah, that was the second thing. Really, it was whether it was air and temperature resistant that I was initially interested in. But I have a couple of other ideas now.

Florence: It sounds really interesting. I'd love to look at the draft when it's ready.

8.2

Florence: So some things that you need to remember when writing the results section are, well, first, as I said when I looked at the draft paragraph, you should only present the results. Without any interpretation, without any methodology.

Max: Yes, I've got that now.

Florence: OK, so the next thing to think about is being sure you highlight both your key findings ... and any secondary ones, too. People sometimes only put in the main finding, but there's often more which is interesting.

Max: Great, so how do I order them?

Florence: OK, so what I'd do is prepare the figures and tables, to summarise the data ... and then basically think about the most logical order to present that data. That's the order your results section should follow. Or at least that's how I do it.

Max: Follow the order of the visuals, right. That's good advice.

Florence: Yeah, so it's like writing a story. It kind of develops step by step. First step, then second step based on the results found in the first step, and so on. It's also helpful to paragraph your text so that each paragraph is clearly related to one of your research questions, or a part of your research question.

Max: So I'd have, say, one paragraph about the stability of the layer in air, another about its reaction to temperature? Is that what you mean?

Florence: Yes, exactly. And make sure in your text that you include references to the relevant visuals.

Max: So by saying 'figure 1', 'table 2', things like that.

Florence: Yes, phrases like 'as shown in figure 1' are really useful.

Max: And language tips?

Florence: Oh, well, being concise – not using too many words – is the thing I find most difficult. Erm, what else? Oh, I usually end up with lots of passives, but Dan always says to include as much active voice as possible.

Max: Right, so different to the method.

Florence: Mmm, yeah. And use past tenses. Oh, and something else he says is try not to be repetitive in your structures. I often do that.

Max: Right, that's great, Florence. Thanks.

Florence: One last thing. It is OK to use subheadings, if it makes things clearer – for example, if you have done a few experiments and have a few different sets of results.

Max: Oh, right. I didn't know that. I don't think I'll need headings, but I'll keep it in mind.

8.3

Max: So, my discussion section should explain how my results relate to my hypothesis; what they mean?

Florence: Yes, so for example you could talk about how the fluorine groups are important for electron transfer. That would be an interpretation.

Max: OK. So, in terms of the order – should I work through my discussion in the same order I used for the results?

Florence: Yeah, definitely. You need to basically comment on all the results you mentioned, in the same order, and say what they mean.

Max: And can I mention any new results in this part? Or just the ones I've already written about in the results section?

Florence: If it's a result worth mentioning, it should be in the results.

Max: And do I need to mention the results again? I assume not, but don't I need to remind the reader what the results were, before I interpret them?

Florence: Well, that's a tricky one. You certainly don't need to mention all the results in detail, but you're right, you might need to make a reference to them.

Max: So how can I include that information, but without repetition?

Florence: Well, you can use noun phrases. That's a quick and easy way to sum up your results without having to describe them all over again.

Max: Right, I see. So I'm not actually repeating the results, more summarising them further. And can I refer to other work that's been done in the area?

Florence: Oh sure. It's good to tie your work in to what others say to support your interpretation. Or to other work you've done.

Max: And in terms of language, is there anything in particular I should be careful with?

Florence: Well, the most difficult thing I think is being concise; not using too many words. But that's always a problem for me too, actually.

8.4

Dan: Yes, this looks good, Max, but I think you should add a short section on limitations and your future plans.

Max: And that's part of the discussion?

Dan: Yes, just a paragraph at the end is fine. Just before your concluding paragraph.

Max: So what kind of thing would I say?

Dan: OK, well one of the things you mentioned here is that increasing the annealing temperature seems to cause desorption.

Max: Yes, above 75 degrees.

Dan: Yes, but it could be that annealing in a vacuum is playing a role. I mean, it may well be that you need higher temperatures at atmospheric pressure to remove the layer.

Max: Oh, yeah. I'd thought about that but I thought if I mentioned it I should really do the experiment.

Dan: But then you'd never get the paper done ... and it would be a very long paper if you covered all the possibilities. No, it's fine to say that's something to be looked at, but start doing it as soon as possible, before someone else does it.

Max: All right. So another thing that's maybe a problem is that I can't get the graphene samples totally consistent. You can tell from the spectroscopy data that there are slightly different thicknesses.

Dan: Mmm.

Max: I don't think it's a big issue, and I'm not sure how to get around it, but it is a bit of a problem.

Dan: Well, perhaps ... but I think it's basically inevitable.

Max: Yeah.

Dan: So, do you have any other ideas for extending the work?

Max: Oh, absolutely. Something else I want to do is look at a way of applying the F4-TCNQ layer. This time, I used evaporation, but I'm wondering if we could just dip the sample in an F4-TCNQ solution.

Dan: Yes, it's worth a try.

Max: Yeah, I think so. I mean, if it works you'd be able to take a ready-made graphene object, dip it in the solution and alter its electronic properties. It's definitely got potential.

9.1

Svenja: That all looks good, Mya. You've really done a good job. Now, the abstract.

Mya: OK, here it is. So basically what I did was take the most important sentences from each of the sections and put them in order.

Svenja: Yes, that's a good way to start. As you write more, you'll be able to write the abstract independently, but that's a good technique at first.

Mya: Oh, good.

Svenja: So, here you have a nice clear background to the topic. That's a good first sentence. But you should never reference other people's work in an abstract.

Mya: Really? But if I don't refer to other work, doesn't that make my work seem less relevant? Less credible?

Svenja: No, not at all. You'll reference them in the introduction. The abstract should be very general – not focused on particular evidence.

Mya: Right. Just in the introduction and discussion then.

Svenja: Well, mainly there, yes. All right ... so next you mention your research question ... good ... that's a nice clear phrase to use.

Mya: Oh, good.

Svenja: And you've narrowed things down to which kind of protective condition you are looking at. Oh, but don't go into so much detail here. I mean, is it really the composition of the surface which has an effect?

Mya: Oh, erm ... I don't know.

Svenja: Well, just leave the first part and take away from 'due to the fact' onwards.

Mya: OK, so next I've summarised the method.

Svenja: That's good, and you have another good introductory phrase there ... but you have included way too much detail. All this about the composition, temperature and radiation can go.

Mya: Yes, I guess if someone wants to know all that detail, they can read the method.

Svenja: OK, next problem is you've got a reference to your figures here.

Mya: Yeah, the line graphs of exposure time and growth.

Svenja: Don't include references to figures in the abstract either.

Mya: Right ... and how about the language, is that OK?

9.2

Mya: So, I have a few ideas for titles sketched out, but I don't know which is best.

Svenja: OK, let's have a look then. Right, well, this first one, 'Is there life on Mars?', is no good.

Mya: Yeah, I didn't think it would really be suitable, but I thought it was good to have something catchy, jokey though, with a fun reference.

Svenja: Well, I don't know if that's true really. Look at it this way, will all your intended audience understand the reference you're making? If they do, well, they'll chuckle ... but if they don't get the joke, all you're left with is an extremely vague title.

Mya: That's true, I guess.

Svenja: And looked at another way, who is going to find it when they're searching the online journals?

Mya: Well, someone who searches 'life' and 'Mars'?

Svenja: But would someone in the field search for such vague terms? Your title needs to contain the important keywords that someone would search for – otherwise it won't be found.

Mya: OK, so how about my second one: 'Are there any features on Mars that could provide protection against the harsh surface conditions?'? It's got the idea of Mars, protection, the harsh conditions ...

Svenja: Yes, that's true, but it's still rather vague. It seems that what you've done here is just use your research question as your title.

Mya: I thought that would be a good idea. I mean, that tells people what I was looking at.

Svenja: Yes, but that title could have been written before you did the research ... and anyone can ask a question. What you can do now though, after your studies, is give us an answer to the question. So instead of using the question you asked as your title, write a statement telling the reader what your key result was. That's much more informative.

Mya: So this one – 'An investigation into whether Mars's surface material could provide protection for organisms' – is better. It explains the key finding. I mean, it kind of sums up the content.

Svenja: Well, it does to an extent, but it's still a little imprecise. Protection for organisms? For dogs? Cats? Humans?

Mya: For some organisms?

Svenja: Why not tell us which ones? It's often good to include details like the species studied, or if you're focusing on one field location, the place – things like that are important. Also protection. Protection from the rain? Say what they're protected from.

Mya: Oh. I thought it would be confusing if I used too many technical terms.

Svenja: Yes, you're right, being too technical isn't good – but this isn't jargon, it's detail. And again, 'an investigation into' tells us what you did, not what you found. Try to avoid starting with phrases like 'an observation of' or 'a study of'. Your next suggestion 'Protection for *Acidithiobacillus ferrooxidans* and *Deinococcus radiodurans* exposed to simulated Mars environmental conditions by surface material' is much, much better.

Mya: But a bit too long?

Svenja: No, I don't think so. I mean, it tells us about the key finding – what you found, in what organisms, under what conditions – it's probably the best of the lot. It really does encapsulate what the content is ... yes, it's the best.

Mya: So maybe it's a good idea to write out what the key finding is and then use that to form the title?

Svenja: Yes, often you'll then just need to use more nouns ... to make it more like a title and less like a sentence.

10.1

Milan: Good afternoon, everybody. I'd like to start by thanking you all for coming to my talk today. My name is Milan Poborski and I'm a PhD candidate at Northumbria University. I'm going to talk today about my recent research investigating the possibility of detecting the secretion of the cytokine MIG, or CXCL9, as a way to measure vaccine-induced T-cell responses. The research was done in the context of a phase 1 vaccine trial of a recombinant viral vector vaccine. To start with, I'll explain briefly how T-cell responses have generally been assessed and outline some of the reasons why this method is imperfect. After that, I'll describe the alternative method I have been investigating, and present the results I have obtained using this method. Finally, I will discuss why this method could be useful as a way to measure vaccine-induced T-cell responses. I plan to talk for about 40 minutes, leaving plenty of time for questions at the end of my talk.

10.2

1 A number of potential vaccine types have been developed and I will be returning to those shortly.
2 As I have already said, counting interferon-gamma secreting cells has been the preferred method to date.
3 As you can see from this image, using flow cytometry to detect MIG secretion gives a more accurate way of measuring immune responses.
4 Let's begin by looking at the size of the malaria problem. Malaria kills over one million people every year in 109 countries.
5 That's all I have to say about the vaccine itself, so now I'd like to move on to looking at judging the response of the immune system to the vaccine.

10.3

1 As I mentioned earlier, there are a number of different vaccine types, but the one I have been working with is an attenuated viral vaccine developed by the ...
2 The immune response to the vaccine has been measured using the *ex vivo* interferon-gamma ELISPOT, which has had some problems, and I'll deal with this point later.
3 We've looked at the methodology used, so now let's turn to the results.
4 In fact, the charts here indicate that detecting MIG by flow cytometry and RT-PCR is actually more sensitive than detecting interferon-gamma with these methods.
5 Next we'll look at the potential application of this alternative method.

10.4

Milan: So let me recap what I've said. Many methods are currently being investigated to measure the immune response to the malaria vaccines under development. Using MIG as a marker has the potential to increase sensitivity, without needing to increase the volume of blood needed. I therefore believe that intracellular staining for MIG could be used alongside current methods to detect vaccine-induced T cells. That brings me to the end of my talk today. I would like to thank you for being such an attentive audience and I would be happy to answer any questions you may have. Thank you.

10.5

Conversation 1

Milan: And which session did you say you'd just been to?

Mosi: I don't think I did! I went to Zak Meyer's paper on blood-stage vaccines.

Milan: Ah, yes. The abstract for that one looked interesting. How was it?

Mosi: Well, to be honest it was a bit too clinical for me. I thought it was going to be about vaccine development.

Milan: Oh, and it wasn't? That's what I thought from the abstract ...

Conversation 2

Milan: Sorry ... erm, excuse me, do you mind if I join you?

Freja: No, no, not at all.

Jacob: Jacob Sachs.

Milan: I'm Milan Poborski.

Jacob: And this is Freja Pedersen.

Milan: Nice to meet you, Freja.

Conversation 3

Milan: So where are you based, Freja?

Freja: Oh, I was at UF with Jacob, but I'm at UND now.

Milan: Ah, right. And what are you working on? Parasitology, right?

Freja: Yeah, that's right. And you, Milan? What are you looking at?

Conversation 4

Freja: Milan, do you know Makareta? She used to do parasitology at UND, too.

Milan: No. Hi.

Makareta: Nice to meet you, Milan.

Milan: So are you giving a paper here, Makareta?

Makareta: Oh, well, I gave it yesterday ... late in the afternoon, unfortunately.

Conversation 5

Milan: So Makareta, have you been to Cambridge before?

Makareta: No, it's my first time. It seems nice though. Not that I've been out much.

Milan: Well, how about you come out with us tonight? A group of us are going to go to a restaurant.

Makareta: Yeah, that sounds good. Look, sorry, Milan, but I have to go. I said I'd meet a friend to help her practise her talk. I'll see you later on though.

Conversation 6

Milan: Freja! I've been looking for you. So, how did the talk go? Did you get a good turnout?

Freja: Yes, it was fine. I was so nervous, though! But I had quite a few people – not too many – and I got some really good questions, so that was helpful. And I can relax and enjoy the rest of the conference now.

Conversation 7

Makareta: So which other sessions have you been to today, Milan?

Milan: Oh, well, I didn't go to anything this morning, because I wanted to have a final practice before I did mine.

Makareta: Fair enough.

Milan: But this afternoon, after I'd been to support Mosi with his poster, I went to a couple on vaccine development. One was by Joan Cummings ...

Conversation 8

Milan: It's good to finally meet you, Jacob, and put a face to the name. I've just been reading a lot of your lab's work on TNF receptors and malaria protection.

Jacob: Ah, excellent. And you said you were at Northumbria, Milan? Do you work with Percy Grey?

Milan: Yes, that's right. Erm, Jacob, this might seem a little forward, but I wondered what opportunities there were in your lab for post-doctoral positions ... I mean, I'll be handing in soon, so hopefully ...

10.6

1 Excuse me for interrupting. I really enjoyed your talk.
2 Oh, I've just noticed the time. Good luck tomorrow.
3 Nice talking to you. I'll see you around.
4 I want to talk to you.
5 I'm going now.
6 Sorry to interrupt.
7 I'd better go and find my colleague.
8 I'm Jose-Luis. What's your name?

10.7

Participant: Hi, excuse me. Yes, um, I was just wondering, could you tell me a bit about your work here?

Mosi: Oh, hello, yes of course, well, we know that viral-based malaria vaccines could contribute to the prevention of the disease and most studies so far have focused on describing antigen-specific T-cell responses to these vaccines. My research though focuses on changes in Natural Killer cell populations which may act directly as anti-malarials, or could be influencing the T-cell responses. In this study, human volunteers, who had not had malaria, were vaccinated with a viral-based vaccine, and then the T-cell and NK-cell responses were measured. As you can see in this chart, numbers of $CD56^{bright}$ lymphocytes increased significantly following vaccination, while the number of $CD56^{dim}$ cells did not increase. The second graph shows that there was no significant correlation between the CD56 populations and the antigen-specific T-cell responses. It seems then that measuring antigen-specific T cells is more meaningful than NK cells as an indicator of immune response in these vaccination regimens.

Participant: Interesting, interesting. Just one thing though. Could you just clarify how the NK cells ...

10.8

A

Mosi: The important difference here is the way the two cell types contribute to the immune response. As I was just mentioning to the gentleman here, $CD56^{bright}$ cells produce a range of cytokines which stimulate other cells. They are not killers themselves. The $CD56^{dim}$ cells, however, are cytotoxic, so they are actually killer cells. Is that what you wanted to know about them?

B

Mosi: Yes, of course. The T-cell responses were measured using *ex vivo* ELISPOT. The NK-cell population was determined by flow cytometry and intracellular staining. If you want to know more about the specifics of the protocol or the reagents I used, just send me an email. The address is here, on this handout and on my card.

C

Mosi: Sure. So I mentioned two kinds of NK cells; those which are $CD56^{bright}$ and those which are $CD56^{dim}$. The bright kind don't actually kill, despite the name. What they do is secrete cytokines like interferon-gamma which can then stimulate the helper T cells. Does that answer your question?