Andrew Saintsing: Hi, you're tuned into 90.7 FM KALX Berkeley. I'm Andrew Saintsing, and this is The Graduates, the interview talk show where we speak to UC Berkeley graduate students about their work here on campus and around the world. Today I'm back in KALX's recording studio for the first time since COVID, and we're trying it out, and we're seeing what's going to happen. I think the audio quality might be better, but who knows? I might mess something up. But I'm excited. Today we're joined by Emily Lam and Kaitlin Allen, both members of the Department of Integrative Biology and members of the Vazquez-Medina lab. You may remember them from that special episode with the Williams lab. They were both on the cricket hunting trip in Sedgwick, but that's not really what they do for their own research, and we're going to talk more about that. Welcome to the show, Emily.

Emily Lam: Thank you for having me.

Saintsing: So great to have you here, and Kaitlin.

Kaitlin Allen: Thank you.

Saintsing: So great to have you here as well. It's fun to actually be finally doing this. So, I guess we're kind of doing: I'm interviewing the two of them, but secretly Emily is also interested in being a host, and so, she's going to kind of act like my co-host. I told her that we were going to do a Conan-Andy Richter thing, and she said I don't know who those people are. So, I'm feeling good about that dynamic. So Emily, what do you think? How do you think it would be a good way to start this conversation? What would you ask Kaitlin first?

Lam: I think the thing is I know Kaitlin pretty well, but I think she has a lot of interesting stories to tell. I'm sure. So, Kaitlin, what is your favorite part about doing research with seals and diving?

Allen: I think the fieldwork probably. I think the lab work is cool. You get to kind of take an interesting wild system and turn it loose in the lab, but I would say that like excitement-wise it's definitely more fun to be at the beach or kind of outside.

Saintsing: Cool, cool. Good start. So, as we established now: Vazquez-Medina, all about diving, right?

Allen: And stress.

Saintsing and Lam: And stress.

Saintsing: And you mentioned seals. And so, seals … you study how seals dive basically?

Allen: Yeah, so I study — I've studied Weddell seals in the past, but I study the elephant seals here in California now, and so, they're one of the best seals, or they are the best seal diver. So, we kind of study how they modify their physiology in order to dive for up to, you know, an hour and a half or two hours at a time.

Saintsing: Modify their physiology. What do you mean by that?

Allen: So, well so, they're basically like kind of a scuba tank on the inside, right? So. if we're going to dive for a long time, we've got to take oxygen with us, and the seals are kind of the same, right? So, they're mammals, so they don't have any gills. And so, they're bringing oxygen with them, but they don't have the, you know, the benefit of being able to wear kind of a scuba pack. And so, they're basically packing oxygen into their blood and their muscles, and then, during the dive actually they're using like way more of it than we would tolerate. So if you have blood oxygen levels similar to a seal at the end of the dive, you're feeling pretty bad. But a seal kind of pops back up to the surface takes a couple of breaths and goes back at it again. So, we're kind of studying how they … you know, why do they feel fine at those really low oxygen levels, and you know, what are maybe some parallels we can draw to why in humans it's not well tolerated.

Saintsing: And this is similar to what you study as well, Emily, right?

Lam: I don't study diving.

Saintsing: Oh, okay. What do you study?

Lam: So yeah, now I study stress in marine mammals. The overarching theme is anthropogenic stressors. I'm interested in looking at whales, California sea lions, and also elephant seals, and it kind of ranges from whole organism stressors like the effects of climate change and habitat on the ability for a seal to thermoregulate down to the cellular level. So, we know that whales are stressed in their environment, we know that shipping sounds or sonar can affect the way that animals communicate and can cause elevated cortisol, but we don't know if it's biologically relevant. So, we're trying to build a cellular model to understand the effects of stress using some tools in cell culture. So, we're taking skin cells from these animals, we're reprogramming them to make these muscle-like cells, and then we're going to see the effects of stress on a biologically active tissue like muscle.

Saintsing: So, you're just stress. Nothing to do with diving. Although it sounds like diving can be pretty stressful?

Allen: Yeah, so the elephant seals, a lot of the kind of the classical stress that we think of in that species is actually when they're on land. I don't know how much is known about stress hormones during dives actually in those seals, but they're on land for, you know, a month to several months at a time at a couple different stages in their lives. And during that time, they're usually doing like sort of stressful things so to speak. So, they're either … if they're pups, they're developing. If they're females who've just had pups, they're nursing that pup, and they're doing it while they're fasting. So, that's kind of like an energetic stressor. They're breeding, they're fighting. So, we know that there's big increases in stress hormones during those terrestrial periods and that they tolerate them really, really well.

Saintsing: So, question. Okay, so stress. You mentioned like thermoregulating (so controlling temperature), growing, interacting with others — other members of your species —interacting with other species, dealing with human sounds. Is there anything in life that is not stressful?

Allen: I don't know. You're asking grad students.

Lam: Yeah, I think there's a reason that we study stress because we're interested in how it relates to ourselves. I think we all have undergone stressors, and we are curious to know what the like physiological implications of that are, but it's anything that really pushes you out of homeostasis. And then in modern environments, there's a lot of different stressors, both natural and human-induced, in the lives of these animals.

Saintsing: So, when you say stress though, it all comes down maybe to some underlying mechanism that unites all these phenomena like? Because you're interested, you mentioned, in cell cultures. So at a cellular level at least, are all of these things kind of having a similar effect?

Lam: Sure, so not necessarily exactly the same, but stress … in general, stressors will all kind of recruit the neuroendocrine stress response. So regardless of the type of stress that is applied, you'll often get these same responses. So, that kind of takes us back to that first chapter where we're looking at the effects of stress on whale cells. You'll see under the stress condition really similar changes (increases in glucocorticoids) which are mobilizing energy stores so that when you're in this kind of stress response you're not really focusing on things like reproduction or you're kind of putting those things on the back burner and you're really just … The classic example is like running away from a cheetah. When you're running away from the cheetah, you're not worried about if you're going to reproduce or digesting your lunch or anything like that. You're just running away from that cheetah. You're getting your muscles moving so you can run. So, it's really mobilizing those energy substrates to fuel vital organs like the brain, the muscles, and save your life essentially.

Allen: Well, and I think your work is cool, too, because it highlights, right … So, if we go with this cheetah example, right? Like running away from a cheetah, very important to survival, right? Like definitely don't digest your lunch. Start going. But then if suddenly there's like this huge increase in the number of cheetahs you encounter day-to-day, you know, walking around Berkeley or whatever, then you might never get around to eating, or you might never get around to sleeping well or whatever else it is that you do during the day. And kind of similarly with these animals, like they're built to handle stress, but if we as humans have kind of added or affected the ways in which they interact with those stressors or the frequency or the duration, then the response is sort of appropriate, but the outcome doesn't kind of yield like the survival increase that we hope, right? So if you're a whale avoiding a ship and you usually encounter one ship every (I don't know) 10 days (I'm kind of making up the numbers here) and suddenly you run into a ship every 10 minutes, then you know you're having to redirect, like you said, all these resources. And it's important, but it's also really detracting from, you know, all the other whale things you do in a day.

Lam: Yeah, exactly. So, we're kind of differentiating between an acute stressor, which is adaptive, versus a chronic stressor, which is maladaptive and can be pathological.

Saintsing: Kaitlin's interested in diving. Emily's interested in stress. What kind of unites you? Why are you in the same lab? Are there overlaps between how you do research?

Lam: We both like to do fieldwork. I think that's a similarity. I'm sure there's lots of them, but I think Kaitlin and I have spent a lot of time in the field together working on various aspects of our projects which have really like united our projects. So, we both will go out into the field and collect samples, some for her projects, some from my project. And so, that's kind of a way we collaborate a lot in our lab through fieldwork, and we all kind of help each other out with the different types of cells that we're working with. So, Gaby our lab mate works with turtles. We help her out with her turtle cells in the lab. So, I feel like we're a very bonded collaborative group.

Allen: I think we have a lot of methods overlap, too. So, we sort of all study systems-level phenomenon that are like difficult to access in your study species. So, Gaby also studies diving and stress in turtles, and, you know, if your study species spends a whole bunch of its time hundreds of meters down in the ocean and you're trying to measure what's happening in their muscles or what's happening in their blood or their blood vessels, we're not quite there yet technologically. I think there's a lot of stuff coming up that people are starting to use now that does allow you to see what's happening, you know, during the dive or across the season that this animal's at sea, but we all kind of have this problem essentially of not being able to access, you know, the thing that's really the question. And so, developing this cell culture system in the lab as a tool to kind of recreate that diving or stress scenario where we can access it really easily. You can go in, and you can give stress hormones to the cells, or you can change the oxygen that they're seeing, and you can do it every single day of the week if you want. Versus you know, having to install something on an animal that may or may not work, you know, may not work. They may not come back with it. It might fall off. The technology may not exist at all. So, I think we kind of all have this like this lab method that tries to recapitulate the diving or the stress system in a controlled environment where we can really get at the mechanism more so than just by looking at these bigger patterns that the animals have.

Saintsing: Wait. So, okay. Cell culture. Thinking of like a petri dish?

Allen: Yeah.

Saintsing: So, flat on a dish.

Allen: Yep.

Saintsing: Are you … what … how … what does your system do that's unique?

Allen: So, my system. So, I study oxygen and hypoxia tolerance, and I study it in blood vessels in seals. And the reason being that those vessels are what's seeing the changes in oxygen concentration really directly, right? So, your blood is in your blood vessels, and so, if you have high or low oxygen, then those cells in the blood vessels are going to see that. The way that we access the blood vessels is actually through the placenta, but we've kind of said it's difficult to get, you know, every single tissue in the world from a marine mammal. It's difficult for a good reason, but you know, a blood vessel. I'm using all of my blood vessels right now. Like I'm making great use of my carotid arteries and my aorta and all this stuff, right? But when a seal gives birth, the placenta is also delivered just like with every other mammal, and it's a super vascular organ because its entire job is to exchange things between the mom and the fetus, and it does that by vessels the same way we move other substances around our bodies. So, we snag this placenta before the seagulls do, and then we can take that to the lab. The tissue is essentially still live, you know? It's separated from the animal, but that, some of the cells are still alive. And then, we can culture those cells in the lab. And what I'm working on right now is putting them in this essentially diving box, this hypoxia chamber where we can manipulate the oxygen concentration that they see. And we can mimic a dive cycle or multiple dive cycles or a long dive and see what types of either cellular-level changes or like gene expression changes that those cells are making as a result.

Saintsing: It's like … what's it look like? What's the setup look like?

Allen: It's a glove box essentially, if you've seen a glove box. But if not: if you've seen any type of social media post from the International Space Station where they're like growing the lettuce and everything, it looks slightly less cool than that, but it essentially looks like that. So, it's this big box with a glass front. And then, these sleeves that go in it, and actually Emily's been using it a bunch lately. So, you stick your hands through these sleeves with these rubber cuffs, and then the environment you're reaching into is essentially sealed. So, you can, you know, you don't have to lower the oxygen in the room. Like, we're breathing regular old room air, but the cells are, you know, "breathing" this lower oxygen atmosphere. And it's also very hot inside, because the cells, these are mammals that we're working with, so physiological temperature in mammals is the same as us: it's 98.6 degrees Fahrenheit. And so, when you take the cells out of an animal and you want to keep them growing in the lab, they have to be that same temperature. So, inside the box it's like 98 degrees. So, your hands are in there sweating. But yeah, you're kind of working in this constrained environment.

Saintsing: So, you pushed back when I said, you know, diving is stressful. But you are lowering the oxygen content. But your point is just that that's something that seals deal with.

Allen: And it very well could be stressful, I think. Yeah, and I think that's kind of … There's this idea, and I'm blanking on who always phrases it this way, but that you kind of have this stress bucket, right? And so, you can handle so much stress of any kind, and you know, perhaps these seals have kind of allocated X amount for diving — same way that we do exercise, right? So, if you train for an event, then you know you're allocating certain a amount of your stress tolerance toward that training that you're doing. Because it is stressful, right? It might benefit you in the long run, but it does cause, you know, changes in muscle physiology, changes in cardiovascular physiology, so you've got to put some energy into that. But then if you're, let's say, disrupting the dive because there's a ship, or there's more predators, or there's less prey, and so they're changing their foraging habits, then I think you kind of potentially exceed the stress bucket allocation for that activity. So, it's not necessarily unstressful. I don't know if there are actual cortisol measurements during those dives, so I don't know that I could tell you exactly. But it's a form of exercise essentially, so it's not unstressful, but it's kind of like stress that's a typical part of their lives as opposed to some of these more atypical or anthropogenic stressors that are becoming typical, that they're seeing kind of like with greater frequency now.

Saintsing: Right, and those are kind of where Emily comes in. And you're actually using the same setup to look at the effects of some of those anthropogenic stressors on cells and the animals you're interested in?

Lam: Well, so the reason I'm using the hypoxia chamber right now is just because another challenge of our system is that you have to optimize every cell type and condition from different species, and they don't all like the same thing. And so, right now I'm trying to grow humpback whale cells, and we started growing them, and they have this morphology that looks like a scrambled egg or a fried egg. So, they just look like splattered, really unhappy. And we're, at the moment, trying to figure out what they like, what differences … So, some things you can do is you could add some substrate, or a matrix, to the plastic to see if they like to hold on to something different. And another thing we're experimenting with is putting them in hypoxia to see if maybe that will help them to grow better, have a more healthy morphology, and whatnot. So, a lot of it is just troubleshooting different conditions that enable these cells to grow.

Saintsing: So, you just have to figure out what makes the cells happy before you can figure out what makes them stressed.

Lam: Yeah, exactly.

Allen: You got to get past the cellular temper tantrum first. I will refuse to grow unless you feed me X, Y, and Z, right?

Saintsing: Have you already, like, managed to get a particular organism cells to grow in the, like, right conditions?

Lam: Yeah, we've done a pretty good job of figuring out how elephant seal cells grow. All the … lots of different types of cells. So, Kaitlin's doing the endothelial cells. I've been working on fibroblasts, and then a postdoc who worked with us, Julia, did a lot of this work in the muscle cells. So, she grew the muscle cells from elephant seals and then differentiated them into these multi-nucleated fibers that actually will contract in culture. So, that's kind of the idea for me is to get my whale cells happy enough that I can reprogram them into these muscle fibers like Julia's elephant seal cells. So, really getting that comparison. But yes, so far elephant seals have been very more or less easy for us to grow compared to some of the other species that we've tried.

Saintsing: And you're talking about reprogramming that's cool. Do you always get placentas? Is placenta's like the only type of samples you get?

Lam: Nope. So, the skin and muscle. We are able to take little biopsies from seals, and the nice thing is seals are on land, so we're able to take a small sample of skin and muscle, and that's how we're able to get our samples.

Saintsing: And then, you can take that skin, and you can make it into muscle?

Allen: That's the idea.

Lam: Yeah, that's the idea, in theory. Stay tuned.

Allen: Yeah, it's a work in progress. People have done it in other … in mice, of course. Always in mice. So, it's out there. It's just now you've got to get it to work for the whales.

Saintsing: Great. Question: okay, if you take a skin cell and you force it to act like a muscle cell, would that not be stressful for the skin cell?

Lam: That's a good question. It might be. But yeah, I mean, we'll have to, we'll have to have lots of controls to make sure that there's different levels of stress that are being applied, and that the cells have kind of found that the right conditions in order to be as happy as possible.

Allen: Well, and that's what's cool with your elephant cell side of this, too, right? So, for the whales, you're having to take these skin samples because the muscle's inaccessible, and you can reprogram those skin cells to make, like, well, maybe-muscle. Get kind of like impossible meat for whales. And then in the seals, you can actually grow the muscle, right? And so, then you can compare. Okay, if we reprogram seal skin to be seal maybe-muscle, what does it do? You know, in comparison to the ones that are actually just muscle. And then, that'll kind of give you a baseline for, you know, do we trust our conversion here? Or you know, what things might we be able to test or might not be able to test in that system?

Lam: Yeah, definitely. So, I think that's another strength again of all of our systems, is having these abilities to compare between different species that have different life histories. So, some are more accessible than others, and we can compare different types of cells and different conditions on them.

Saintsing: Well, that sounds really interesting and cool, but also I want to hear more about field work because you all work with marine mammals. So, you work with elephant seals, so you spend a lot of time at Drake Beach?

Lam: Drake's beach. And then Año Nuevo State Park down in Pescadero.

Saintsing: Nice, and you have to like wrestle the elephant seals?

Allen: So, no. You try not to. It's a very highly permitted process,

Lam: And biologists are trained and skilled to, you know, be around the elephant seal, so we go through a lot of training to understand how to interact with them and all that.

Saintsing: Okay, so Emily is more on the stress side. So, I've actually been out in the field.

Lam: That's true.

Saintsing: Yeah, we had a good time. We studied … we got temperatures, right?

Lam: Yep.

Saintsing: So, when you're out in the field, what's the process there for you?

Lam: So, for that project, that's the project that's looking at the effects of essentially the habitat on elephant seals. So, we're comparing Año, Point Reyes, and then also the Farallon Islands. And we're taking thermal images of the seals to allow us to understand if they're able to offload heat. So, imagine you're wearing like a big thick winter coat on a beach, which is normally not too hot, but as conditions in our climate might change, especially with the increased frequency of extreme heat events in times like December when these seals are out on the beach, you might overheat. So, they have mechanisms to offload heat, where they're like really perfusing blood to certain little pockets called thermal windows. So, we're trying to visualize that using thermal imaging. For that project, I've taken some volunteers out, and we take photos of the elephant seals. We built some weather stations. Kaitlin helped with building the weather stations. We took these three-meter tripods a mile down the beach, so that was very helpful. Thank you.

Allen: I don’t think anyone who carried them was taller than five feet tall.

Lam: Yeah, exactly.

Allen: The three smallest biologists we know. But we got it done. We got them up.

Lam: Yep, and then comparing the different sites. So, a big thing we look for is behavioral things that the elephant seals do. So, they'll flip sand on their back to enable cooling, but some places, like the Farallon Islands don't have sand, so they no longer have this behavioral mechanism to cool themselves off. So, they can only rely on their physiology, so we're kind of seeing if that's enough, if their physiology is enough to buffer them against the effects of climate change, or if they're going to have consequences. And one consequence is that they can no longer live there. And we've been seeing a precipitous decline in the population of elephant seals on the Farallon Islands ever since the sand was washed away due to some storm events in the 90s. And so, we're interested in seeing what's driving these seals away. Like, is it the inability to cool off, or is it something else?

Saintsing: And then, while you're out there, you also, like, if you notice a placenta you call Kaitlin?

Lam: Yeah, exactly. I mean usually every time I've seen one the seals have gotten to it first, but that's … We have uh collaborators who are a little bit quicker than I am, and he'll notify Kaitlin when there's a placenta.

Allen: I get a lot of 7 am phone calls to drive to Santa Cruz in January.

Saintsing: Fun stuff.

Allen: Yeah, for sure.

Saintsing: Okay, so cool. That sounds like a fun field project. And then, you do completely separate field work other than getting placentas.

Lam: She goes to Antarctica.

Allen: Yes, so the placenta, so the placenta collection for the elephant seals actually is the folks in Dan Costa's lab down at UC Santa Cruz. They’re out there like every day in the seal colony, and so, they are fantastic placenta wranglers, and they have been incredibly willing to field my like weird emails about like, "Hey, would it be cool if you like maybe poked around and looked for a placenta and like threw it in a garbage bag and like maybe took it back?" I like didn't expect anyone to take me up on that, and they've been really awesome. But yeah, so I've done some other biopsy stuff with the seals as well for another chapter of mine, and I worked in Antarctica. I caught squirrels for a while.

Saintsing: In Antarctica?

Allen: No, not. No, yeah, the little known Antarctic ground squirrel, cousin of the arctic … yeah, not in antarctica. But yeah, I kind of hopped around a lot. I don't know. I just I mean I like being outside. I like the kind of … like the way you have to think when you do field work especially. I mean it can for sure be super stressful, especially when it's, like, samples for your PhD, but I do really think it like stretches a part of my brain that I don't use quite as much in the lab. So, I guess when I worked in antarctica, we had … usually you're used to, like, taking ice with you places. So, a lot of our samples … I think I said that the cells have to stay really warm, but that's when you're getting them growing, and in the meantime, you try to put them into this kind of sleep mode by keeping them fridge temperature, but not frozen, right? So, you're kind of hibernating them, more or less, for a couple hours so you can get them where you're going. But when you do this in Antarctica, you have the opposite problem. So, instead of taking ice packs with you, you, like, boil a bunch of water before you go outside and put it in water bottle packs in coolers and then hope that you boiled enough water and that it's not so cold out that it'll, like, lose all that heat. And then, you collect your samples and try to keep them in this warm fridge temperature as opposed to, like, whatever minus 30 or whatever it is outside. You're trying to keep things closer to, you know, 10 degrees or 15 degrees or something. Sorry, Celsius, I guess. But I kind of think that that's what I like about it. It's like the strange resourcefulness that you have to have for a lot of it.

Saintsing: I think it's funny when you read scientific papers or something and you don't really know what's going on, but then you have a little more idea, and you just realize like they just like did the best they could.

Allen: Oh, yeah. And then they're trying to like make it sound like not quite as sketchy as it might have been at the time. Like, we used to collect, like, blood and tissue samples, and some of it like can't bounce. Like so, if you collect blood samples, like if you go have your blood drawn at the lab for, you know, whatever analysis they're gonna do, they don't like shake the tubes afterward because it breaks open all the red blood cells and all the stuff inside comes out, and it like ruins your test basically. So, it's not contaminated, but it like makes the test unreadable. And so, we would like go out and take some blood from the animal, same way you do in a lab. And then, you have to keep that blood cold, but not frozen. And then, you have to drive it on a snowmobile like 15 miles back to town where you're then gonna actually do this test. And so, you have to keep the tubes upright, and then you like can't shake them. And they have to be cold, but you know they'll freeze if you leave them out. And so, we used to put them like … if you put them in your outermost pockets, they're frozen solid in like two minutes. If you put them in your innermost pockets, they're like my temperature. And so, you're like, “Okay, you know, blood samples were kept at eight degrees Celsius, which was really like my second inner pocket when I like stood up on the bumps on the snowmobile so they wouldn't shake.” And like, you're kind of just making the most of it, but yeah, it's not perfect, for sure.

Saintsing: Yeah. Similar thoughts about field work, Emily?

Lam: Yeah, I mean Kaitlin taught me a lot about how to prepare for the field. We make these very nicely labeled packets with all of the tools that we need, and then you know midway through, everything just is kind of everywhere. But it's really helpful to have these kind of like really well organized things because it becomes chaotic, but if you have some semblance of organization early on, you know, you'll maintain some of it.

Allen: For 45 minutes you know what's happening …

Lam: Exactly, right.

Allen: … as opposed to for none of the time.

Lam: And then we similarly have, you know, taken our mini portable centrifuge, and instead of taking our blood down the bumpy roads, we centrifuge them in the parking lot with the car battery.

Allen: With a permit.

Lam: Yeah, exactly.

Allen: This is for scientific purposes. Don't worry.

Saintsing: Well, this has been a lot of fun, but unfortunately all good things must come to an end. And it looks like we're out of time on the interview. Is there anything you'd like to leave us with before we go? How about we start with Emily?

Lam: Get out there and see the elephant seals, but make sure you stay the proper distance away from them. They're in a really important time in their life nursing pups, and so, you know, if you do go see them, make sure you give them enough space so that your interaction doesn't have a negative impact on the elephant seals.

Saintsing: They got enough anthropogenic stressors.

Lam: Exactly. Keep your dogs away from them. If the beach says don't bring your dog, don't bring your dog.

Saintsing: Kaitlin, you got anything else?

Allen: Yeah, and I guess, on the flip side is that if you can find a permitted opportunity to do any type of field work, not just marine mammals or seals, anything. But yeah, like I caught squirrels for a while for a plague project. I would definitely do it. It's … you often don't have to know all that much about what you're gonna do. They'll usually teach you, and it's definitely worth seeing kind of like behind the curtain how a lot of this stuff gets done. I think it's a cool experience.

Saintsing: Okay, I know you brought up squirrels, but you didn't drop the word plague, and that's like way unfair because now everyone wants to …

Allen: They didn't have plague, if it helps, in the end.

Saintsing: Well, that's very relieving.

Allen: They didn't.

Saintsing: I don't even know where you were, but I'm glad. Yeah, so … but okay, great. Both great thoughts. Thank you so much for all of that. Today we've been speaking to Emily Lam and Kaitlin Allen, both from the Department of Integrative Biology, members of the Vasquez Medina Lab, studiers of marine mammals for stress and/or diving. Thanks so much for being on the show.

Allen: Yeah.

Lam: Thank you so much.

Allen: Thank you for having us. This was fun.

Saintsing: Tune in in two weeks for the next episode of The Graduates.