DANNY LENNON: Alex, welcome to the podcast, thank you so much for taking the time out to talk to me today.

ALEX JOHNSTONE: Thanks Danny. It's good to join you, looking forward to some good discussion.

DANNY LENNON: Yes, I have so many things I could ask about because I think the first thing people see if they took a glance at your publications is just the breadth and depth of what you've published on over the years. And so, we're going to try and focus down into at least some of those key areas. Maybe before we get into any of my questioning, how would you typically introduce yourself to people about the type of work you do and what you've currently got going on in Aberdeen.

ALEX JOHNSTONE: So I'm based at the Rowett Institute, academic researcher, looking at the relationship between diet and health, and I'm a professor in human nutrition and focus on my team effort as on appetite across the life course. I feel quite passionate about using my science and sharing that with stakeholders and the policy, food industry, or the general public.

DANNY LENNON: Yeah. And I think a couple of the pieces around the appetite control and different types of diets

and how they impact appetite that you've published on, include things that we'll get to, like high protein diets, you've published some on looking at a ketogenic diet. But one of the big things that immediately struck me when looking at the work you've published on, say, a high protein diet intervention or the ketogenic diet was they were done and published at a time where those things weren't nearly as widely used or maybe even accepted as they are now. We're talking more than a decade ago I think for some of this research. How did you focus on these areas where maybe they weren't in traditional nutrition guidelines at the time or at least typically types of diets people used at a large scale? What kind of drew you to investigate into these back then?

ALEX JOHNSTONE: I think that's a really good question. It's down to when I was thinking about high-protein and, particularly, ketogenic diets. These types of diets were invoked, so it was very much I was working against the flow to say, well, actually this doesn't really ring true to me, because the ketogenic diets, for example, said you can eat as much as you want as long as you don't eat any carbohydrates and you'll still lose weight. So in a sense, I very much think of myself as trying to be in tune with current trends, current opinion, and also sit back and question, well, what's the evidence to support that, and what can I do to contribute to the development of science, to help understand how our physiology and behavior combine together to influence the food that we eat. And so I'm very much focused on mechanistic work to ask that why not just does something work how does it work.

DANNY LENNON: Yeah, and I think that's an incredibly important piece to this whole discussion that we will get into, looking at not only what works but why does that work. And also, your curiosity to look at things as they're emerging or before they even become widespread ideas is interesting to me, because it seems to be a notable pattern amongst some of the research you've been involved with. And even now, I know, for

example, you're involved with the big breakfast study that you guys are running up there, which is again an area that maybe isn't on everyone's radar in terms of nutrition. So it just seems that there's this beautiful pattern of getting ahead of the curve on most of these things.

ALEX JOHNSTONE: I think, so you mentioned a broad range of publications, and I suppose that's very much driven by funding as well. You have to be able to use your knowledge and expertise and work with multi-disciplinary teams to stay ahead of the game. So if people are working on research, they need to be adaptable and you enjoy working with different colleagues.

DANNY LENNON: Yeah. So let's focus in on some of those interventions that we just mentioned. First, if we lead off with just high protein diets because, like we said, you've published quite a bit on this. So from maybe an overview level, if we take things from when we weren't really or when you were first trying to navigate, well, what things can we modify within the diet that may impact appetite, and then getting into some of that early work on protein, what are some of the key take-homes that you were able to find within this research that may have implications for diet not only at an individual level but also beyond?

ALEX JOHNSTONE: So first of all, I wanted to design diets that would help people control hunger and appetite, and there was quite a bit of evidence that high protein diets, when subjects were feeding ad libitum, did tend to promote satiety and satiation. I wanted to understand what are the mechanisms that promote protein induced satiety. I did do quite a lot of work looking at different amounts of protein, different types of protein, and trying to tease out the interaction between our physiology and behavior by looking at ad lib feeding in free-living subjects and also lab feeding where we were using fixed diets and using techniques like fat biopsy, stabilizer tools to look at protein turnover. But

the take-home messages from that were that the amount of protein is probably more important than the type, because of course you can get protein from a range of sources, whether it's traditionally from animal-based sources and sort of meat and poultry, but also we can have plant based sources, peas, beans, legumes and not forgetting cereals and other plants. What we mean by a high protein diet is not actually still confirmed, and diets, I use, my research diet is nearly always 30% protein with a slight reduction in carbohydrate to around about maybe 40%, and that will vary depending on how much fat we put that in as well. And I think early on, one of the other key messages was that you didn't need the low-carbohydrate which is connected to the ketogenic component in order to promote satiety.

So in fact, some early work cemented that to my own sort of thinking that actually what we found was when we went on a ketogenic diet, so it's just very high protein and very low carbohydrate between 5 and 20 grams of carbs per day, then you really meant that you missed out on all those beneficial fiber sources that go into the gut; because of course when you eat protein, that's fermented and that can produce some negative metabolites in the gut; and by eating carbohydrate alongside that you can ameliorate that effect. So although ketogenic diets were at that time, in early 2000s, promoted as a diet for life, I very much disagreed with that and thought that the short-term findings, if we extrapolated that into longer term, then I didn't think it was an appropriate diet for life. You need these good fibers going in alongside protein to produce beneficial metabolites through the gut microbiota, through the bacteria. So I've continued working on protein, I suppose, the most recent trends are in sustainable sources of protein. So sustainable, both for the environment but also healthy for human body as well. I'm trying to think about what are the right combinations of protein. I'm still trying to

track down exactly what are the mechanisms of protein juice satiety which are likely to be looking at amino acid flux to have the changes within the body, but also thinking about how protein structure, so how we eat food, because of course we talk about protein, protein is just a term, it's a nutrient, we actually eat food. So how can we translate my research findings in food, so how do we think about it in context of beverages, how do we think about it in context of meals?

DANNY LENNON: Lots to pull back on there. First thing that comes to mind is you kind of highlight that we have at least seen this clear impact of higher protein daily intake on appetite. What do we know about the kind of per meal dose, and then also how we might distribute protein across the day, either in an even manner or skewed manner? Do we have anything there that would tell us something about what that does to say 24-hour appetite or hunger?

ALEX JOHNSTONE: Well, that's a good question. So for the purpose of using protein to promote satiety, then you do need to spread it across the day. For an overweight man or an overweight woman, we are talking about between 30 and 50 grams per meal. So that would need to be spread through breakfast, lunch, and evening meal. And that's because the effect of protein aren't likely to be through the digestion and utilization of that protein and amino acids. And that affects well with the ethos that when you're trying to lose weight, you're trying to mobilize your fat mass and maintain your lean body mass as well. So protein has an important role to play in terms of maintaining that profile to try and improve health.

DANNY LENNON: You also mentioned the kind of need for research to look at protein, I suppose, within the kind of whole food matrix as opposed to in isolation which I think a lot of the work has been done for obvious reasons to kind of elucidate things mechanistically. If we're looking at food sources, and then also, you

mentioned more sustainable plant-based sources as well, just curious from a pragmatic perspective, how do you go about separating the effects of say protein versus say the actual high fiber within foods like beans or legumes that would be used in a, when we're looking at high-protein diets from, let's say, plant-based sources?

ALEX JOHNSTONE: That is actually very difficult. I met a team of dieticians that worked with me to design diets. So first of all, I always design my diets to be isoenergetically similar. So the same amount of calories go in, and then, when you're looking at plant sources, then I tend to feed meat based meal as a control and then have perhaps a range of plant based sources whether it's pea or hemp. So we tend to look at start with acute studies to assess the bioavailability of different sources, and so that would be taking multiple blood samples over a very short time period, and looking at the sequence of the amino acids in blood. And I will then go on and look at specific types of protein, for example. A few years ago we'd done a studying looking at soya protein which I know is not the most sustainable, but it was the most prolific plant based source routine that was available at that time. So I showed that a vegetarian soya based diet was equally as effective at promoting weight loss in direct comparison within the same subjects to a meat based diet. And for me, that was a bit of a breakthrough because it wasn't that I wanted support vegetarian diets per se, but as a research question can we get similar effects in terms of appetite control and high protein vegetable based diet in comparison to a meat-based diet. And the short answer to that was categorically, yes, you can. That opens up the sort of secondary question, well what types of plant protein, and can we mix it in with the diets so we've got a range of protein sources to try and promote health.

DANNY LENNON: One other practical question, when we're talking about things like appetite or hunger or satiety, in most of these studies, what kind of

collection of metrics are you using to measure that, is it just ghrelin levels or is it like a subjective element, how do you combine different metrics, or what is most commonly used?

ALEX JOHNSTONE: My studies are always done within the subject and because a certain subject of appetite, so you ask the volunteers every hour, every waking hour, how hungry do you feel and you do a visual analog scale assessment of appetite, because it's very subjective. If I asked you just now, how hungry are you, it doesn't really tell me that much, it just tells me, gives me a cue as to the likelihood of whether you are going to go and find something to eat. It doesn't actually tell me what you're going to eat and how much you're going to eat. It's just a cue, subjective cue to say that you feel less full and there's a likelihood you are going to look for food. So I'm interested in subjective assessment of appetite, but yes, I'm also interested in the physiology. So I will tend to look at things like what's going on in the brain which can be quite tricky, so we can do things like MRI scans and look at which areas of the brain are activated during fasted and fed state, we can do that across the life course in response to different diets or in response to different food cues when you're lying underneath a scanner. Or we can take a quick look at peripheral and metabolites and hormones, they don't always predict well what's going on, so I think behavior is also important. So we can look at ad libitum intake, so we can do a fixed big breakfast and look at the impact on food choices later in the day. So there's a range of techniques that we can employ very much dependent on the research question. Of course the frustrating thing is that one study never answers all those questions.

DANNY LENNON: Right. We've talked about satiety, and I know often people may use the word satiety and satiation interchangeably. How should they actually think about what those terms mean or what we're describing when we use either of those?

ALEX JOHNSTONE: Yeah, that's a good question. So satiety is used to describe the period of time between eating. So it's kind of think about it between the inter meal interval. So the time that you put down your knife and fork, between then and the next eating episode. And satiation is a little bit different and it's more described as the process that leads to determination of an episode of eating. So I think about that as, when you actually put down your knife and fork, and actually the mechanisms involved in those two aspects are quite different. So from a scientific level, if you want to design studies to assess satiation or satiety, then often you will slightly adjust the techniques that you are going to apply.

DANNY LENNON: So one question I did have is, that at this point but we've talked about how protein and also things like fiber can play a role on both satiety and satiation; and so when we think of the most common foods in our food system right now, it's pretty easy for people to identify that maybe a lot of them are not ideal for controlling appetite in general, which I suppose plays into this kind of bigger question and the importance of some of your work. So if we look at, again what most of the food system looks like, where we have an issue here, one question I had around that relates to how we view processed foods or what generally sometimes gets lumped as "sugary foods", one of the things that comes up with sugar is that if you eat sugary foods that causes you to be hungry and then you're going to eat more. There's an element to that of course, which we can talk about, but there's also, does just eating those foods simply mean that you're eating foods that are typically low in fiber and protein as well, so that's causing the problem, how do we disentangle the impact of, let's say, more technically ultra-processed foods and how that impacts appetite and satiety?

ALEX JOHNSTONE: Gosh, that is a hard question. But so, first of all, a comment on processed foods. Kevin Hall

recently published a paper looking at the role of processed foods on bodyweight. In that study he discussed that actually eating rate was the factor that influenced weight gain in terms of the more processed foods it was easier to consume then over a shorter period of time. Now, that's interesting because it infers that food structure and texture have a part to play in terms of rate of eating. But that has been known for an awful long time, so if you think about beverages, and you think about sugar, and in the context, sugar, it's much easier to consume a glass of, let's say, orange juice, which contains much more calories than to sit down and peel an orange and eat the orange segments. So how you disentangle that is actually quite difficult because the nutrient content of a food will be in part be determined by the sort of processes it's undergone. And essentially, yes it can be useful to sort of take your thoughts directly into individual food items, but I actually think it's much better to think about the whole diet. As nutritionists, we don't tend to think about just your – also, I do spend a lot of time thinking protein, but in the context of eating across the day. So I find that it's difficult to give genetic advice because our genetic advice for healthy eating and for weight loss is just to be thinking about calories and kind of the result, but we need much better advice, and we don't have that; we don't have, as yet, the knowledge to promote a lifestyle medicine approach; we don't have a way of identifying which diets will meet the needs of what type of people; and that will come in the future, that will be your stratified nutrition or, what we call, precision nutrition.

DANNY LENNON: Right, that's an incredibly important point, and I think highlights that need for being, like you say, move towards food based interventions or food based recommendations that people can actually get to grips with as opposed to talking about isolated nutrients. I think that the sugar one is in particularly useful to highlight this because you've already outlined how much things are interwoven within that whole idea of

processed foods; and if people are just putting all of this down to sugar is doing this, it kind of ignores the wider picture. And you can even, if you want to extrapolate it out to again isolated incidents, you could look, well, if someone consumes just sugar and insulin goes up, actually insulin can have an appetite suppressing effect. So it kind of shows that looking at it in that isolation probably isn't the most useful way.

ALEX JOHNSTONE: One of the topics that I'm interested in about processed food is because I actually currently hold an MRC, Medical Research Council, grant looking at food additives. But the question I'm asking there is how do food additives and specifically emulsifier, so we have emulsifiers impact on the gut microbiota. So that's kind of taking the question more in-depth, so targeting a specific type of processing, a specific type of food ingredient and trying to produce the evidence to look at in a controlled setting or a control diet how does it impact the gut microbiota and the metabolites. So that's going to be really interesting to share those results next year.

DANNY LENNON: One thing that I think I wanted to talk about in this area is there's probably two ways we can view interventions from here when we're looking at what does our overall diet or the overall food environment look like and how can people best consume that diet to either maximize satiety, minimize appetite or at least control appetite appropriately to attain a healthy body composition and health over the long term. And one side would be looking at kind of maybe a bottom-up intervention of, on an individual level, what can we advise people to do, and that probably speaks to just kind of personalized nutrition idea. And then also, on a kind of top-down level, is there potential for maybe more of these upstream interventions to modify their production of foods that we know most people in the population are likely going to consume that would lead to maybe knock-on impacts on some of these areas, and then in

turn maybe that could alter, let's say, average caloric intake. So before coming to the individual one, is there anything on a kind of population wide level that you are either maybe optimistic or pessimistic about that we can do to have some of these impacts on the food system and then the food environment that's going to play a role in typical appetite control or satiety for people?

ALEX JOHNSTONE: Yeah. I mean, that's a good question. So I strongly believe that I can share my knowledge and experience with the food sector, and I do do that. So whether it's through consultancies, whether it's through getting grant awards, whether it's through contact research, so that means that I can positively influence the formulation of foods on new product development. So I can take my science straight on to the supermarket shelf. So I think that working hand-in-hand along with the food sector can mean that we have a positive outcome, but these types of products, shaping the change in products needs to be consumer driven. So if we are going to use techniques in order to influence the food that we eat, then we need to think about effective ways to reformulate or to nudge consumers in the right direction. So I've just published a paper and appetite that looks at “nudging” Scottish consumers to think about meat consumption and how that impacts on their environment, so it's thinking about sustainability but also about nudges for reformulation. And my thoughts on that are that I don't think that we are going to see a major shift towards the population becoming vegetarian or vegan, that's not really the message; the message is that, about meat consumption, we should be eating slightly less meat but better quality meat, and how can we produce products that have a perhaps slightly less meat and contain alternative plant sources of protein. So if you think about a beef burger, it could be maybe pink protein isolate, or hemp, so have slightly less beef but it would contain plant source of protein. That's just an

example of how I see this sort of food system change in the future.

DANNY LENNON: Yeah, that's a particularly interesting paper that you just mentioned, I really enjoyed reading it; and maybe just to go a bit further into some of those concepts that were brought up within that paper, one, you already mentioned, is nudging. Can you maybe just elaborate a bit more on that for people of what we're talking about with this idea of nudging people towards, in this case, let's say, more sustainable consumption of meat and how does that look in practice?

ALEX JOHNSTONE: So nudging can be done in different ways, it can be done through sort of regularly even which UK has gone some ways to go for food sector guidance as to who want to see less of, let's say, sugar and fat; but also, it might be through the choice at the time, so it might be through supermarkets only providing a range of products within a certain ethical framework, say, for example, a really good example is now we only see dolphin-friendly cans of tuna. So that is a decision that has been made in order that consumers finally go into the shop, they can only buy that type of product. So there can be different way or it can be subtle messaging. So it can be there's a strong rise in what we see is [inaudible 00:32:03] so people choose to eat perhaps more plant-based product. So in a week, Monday or they will choose products that are branded as a high implant protein, for example. So there's in-store marketing and messaging. But really what we need to see is it's not just up to just the food industry, so it is up to academics, it's up to public health bodies, it's up to a whole range of interactions at a cultural level in order to support these, let's say, healthy eating goals to try and support the population to have a better health through policy. That is a really difficult task and it's certainly not going to be achieved within my working life, it's something that is a long-term goal. That is actually something with been working a lot with if another grant called Protein for Life,

and that was very much working five academic sectors, the food sector ranging from ingredient producers to government organizations to food production and retailers, so working right across food sector.

I think that's the way moving forward is to have a multidisciplinary team working on evidence base and then working with key stakeholders to try and change the way we think about things. For example, the Protein for Life team published a white paper. I'm assured that and reported that when they looked at the Indian national diet health survey in the UK that think about do adults actually meet recruiting goals, well, only 74% of the population over the age of 40 meet current guidelines which is 0.75 grams per kilogram of body weight for protein. So we were discussing our individual goals. So that would be one goal I would very much highlight is, do you actually meet the current recommendations for protein. If you think about the emerging evidence that sees that actually current recommendations should be higher to support a healthy lifestyle, because of age 40, so I'm in that age group, well, in that age group, I don't consider myself as ageing, but that goes to support healthy eating, support the maintenance of lean body mass and to avoid sarcopenia associated ageing. There's no point in waiting until you are retired and after that to start thinking about that. So if we think about how much of the population meets the higher recommendation of 1.2 grams of protein, and it's only 13%.

DANNY LENNON: Yeah, that's incredible. And I think the protein at a kind of wide population level is a good example of something you mentioned just a moment ago about, whilst yes we can do things within formulation in the food industry and making certain changes from a regulation standpoint, there probably also needs to be this intersection with consumer driven movement. So consumer demand causing some of these changes; and within at least protein, it's probably easy to see over the last five to 10

years, the prevalence now of protein users messaging on certain food products and high protein this, high protein that, that has probably been driven by consumer demand, may be largely from maybe a fitness industry perspective, but is now seen across a number of different products that we would never seen as branded as a high protein version long ago. So that's one where a consumer impact has probably led to change in food intake.

ALEX JOHNSTONE: Yes, so I think we have got something called protein power, also I think that consumers still don't understand maybe the message between protein and feeling fuller for longer is getting through, but also consumers don't understand the importance of protein to promote health in ageing. In 2009, I designed a health food range for Marks & Spencer which is now sold as buns for you; and the fact that health food range is sustained since 2010 to now, suggests that consumers are willing to buy into products with a higher protein label; and by trying them and finding out that it actually does help and feel fuller for a longer, it does help with appetite control, then that's incredibly important.

DANNY LENNON: Maybe a much broader and much more difficult question, I don't know, if anyone is able to answer this, but some of these ideas that we've talked about specifically to the change within say meat consumption perspective in the Scottish population, that paper you did and ideas of nudging or formulation of different products or some degree of regulation on the food industry, do you feel that's probably the most likely, if any, solution that we would find in the long term to say that this upward trend of obesity rates and comorbidities – because anytime someone asks me about those and how anyone even goes about reversing that, I'm a complete loss of what could be possibly done, but I'm just curious on a kind of personal level how you see the role of, let's say, public health going forward on impacting something like obesity

rates or chronic disease rates that that are increasing?

ALEX JOHNSTONE: You know, that is the million dollar question, how can we solve the obesity epidemic. And some days I feel quite disheartened that we're not going to be able to do that, to be honest. And then other days, I think, well, actually, the work that I can do, will contribute towards evidence base; and I think that the way we think about obesity and any change in the future, the moment we have genetic advice about calories in and calories out, but actually, in the future, that may change. We need to be moving more towards thinking about which diets will work for what types of people; certainly, my own work, recent work on something called Chrono-nutrition, so timing of eating, that will contribute towards this understanding about the rule of food as a behavior and what and when we eat and what we eat can influence energy bar. And it's about sharing that message with health professionals, policy people, so that they become aware of how our understanding of how the human body works is developing, and how it can be used at an individual level; and that involves education, it involves training, so we need doctors and healthcare professionals get more nutrition training. So that embraces lots of different issues, but I think looking forward to the future, there are sectors that are open to that change.

DANNY LENNON: Right. And I guess, the most difficult thing is there's going to be some degree of a lag time between the research that's done now and interventions that are put in place before those things will have time to percolate and actually impact those rates of certain, say chronic diseases in the long term; nonetheless, I think there is that important work being done. We could have stayed talking for a lot more stuff Alex and even as you bring up Chrono-nutrition, one of my favorite things to deep dive into and I know you guys are doing great work in that area, we'll have to have you back

on to discuss some of that at another time point. But before I let you go, I'll finish with maybe one kind of final question of your current projects going on or current planned work or anything that you see envisioning come out of your lab, let's say, in the next five years, what are some of the kind of big questions you're looking to answer or what projects are you kind of most excited by?

ALEX JOHNSTONE: Yeah. So I'm most excited about the work that I'm doing on Chrono-nutrition. So Chrono meaning time of day nutrition and what you eat. So that work has strongly embraced the ethos that the time of day maybe as equally important as what we eat to influence our bodyweight; and certainly, I'm in a lucky position that I can actually combine both. So if you think about what we eat for breakfast, I can combine that with high protein meals and compare and contrast that to, let's say, high-fiber meals, and look at how and what are the mechanisms involved in timing of eating in terms of thinking about our natural circadian rhythms with the ebb and flow that you see naturally occurring throughout the day; and also thinking about how it impacts on energy expenditure behavior. And I think this will be incredibly important because, currently, we don't have any nutrition guidance for people who work shifts. So if we can understand the interaction between circadian rhythm and what and when to eat, then we will start building up a profile of evidence to address those types of problems, health problems.

DANNY LENNON: Alex, for people that are interested in finding more of your publications or more of your background, is there anywhere on the internet that you can go, research, get anything, is there anywhere they can check out more of the work that either you or the group is doing or social media, anything like that?

ALEX JOHNSTONE: Yeah, so I do enjoy using Twitter, so on Twitter my handle is dr_ajohnstone or they can Google Professor Alex Johnstone and Rowett Institute

University of Aberdeen, and they'll find a list of my current grants and publications. They can always use old fashioned email, I always enjoy discussing science and research.

DANNY LENNON: And with that, Alex, the very final thing I will ask is completely separate from what we've discussed today. It's the way I finish off each episode. Again, quite a generic and loaded question, so sorry for putting you on the spot. But if you could advise people to do one thing each day that would have some sort of positive impact on any area of their life, what would that one thing be?

ALEX JOHNSTONE: I suppose it would come back to thinking about the foods that they're going to eat. So planning in advance the type of foods that they're going to eat, to include protein in their meals, but also to enjoy food, I think that's incredibly important, because we've discussed a lot about mechanisms and studies and research. But food is about enjoyment and we can think about each eating episode as a chance to positively influence our health.

DANNY LENNON: Wonderful. Thank you so much for taking the time to do this. It's really been not only a pleasure but also an honor to be able to talk to you as someone who's read a considerable amount of your work and looks forward to more of it. So thank you for being so generous with your time and talking to me.

ALEX JOHNSTONE: It's been great fun. Thanks for the invitation Danny.