Introduction and Guest Background

– Welcome back to the Reverse Alzheimer's Summit. I'm your host, Dr. Heather Sandison. And I'm so pleased today to welcome Dr. Stephanie Seneff, a senior researcher and scientist at MIT's Computer Science and Artificial Intelligence Lab in Cambridge, Massachusetts.

She has a bachelor's of science from MIT in biology and a master's in science, EE, and PhD degrees from MIT in electrical engineering and computer science.

Her recent interests have focused on the role of toxic chemicals and micronutrient deficiencies in health and disease, with a special emphasis on the pervasive herbicide, glyphosate, and the mineral, and, excuse me, glyphosate, and the mineral sulfur.

Since 2008, she has authored over three dozen peer review journal papers on these topics, many of which I've read and apply in my own clinical practice.

She is the author of a book on glyphosate titled "Toxic Legacy: How the Weedkiller Glyphosate is Destroying Our Health and the Environment." This was released in July of 2021 by Chelsea Green Publishers.

Dr. Seneff, welcome. – It's so great to be here. Thank you for having me. – So let's dive right in. For those who don't know, what is glyphosate, and why do you think that this is an important topic when we're talking about Alzheimer's disease?

– Glyphosate is the active ingredient in the pervasive herbicide Roundup, which people can get down at the hardware store, the garden store and use on their dandelions in the yard or on the weeds in their walkways, very commonly used there, but very extensively used in agriculture, especially since the introduction of what they call GMO Roundup Ready crops, which are crops that have been genetically engineered to resist glyphosate.

So you can just spray the chemical all over the crop, it doesn't die, the weeds die. Very convenient way to control weeds. So it was heralded as a great breakthrough in agriculture back, really first patented, first introduced on the market in 1974, so it's been around a long time.

But really accelerated usage starting about the turn of the century with the introduction of these Roundup Ready crops, corn, soy, canola, sugar beets, these are all resistant to glyphosate so they're heavily exposed.

And there's also a bunch of crops that are sprayed right before harvest as a desiccant, it kills the crop, and that's actually a very serious contribution of glyphosate contamination in our food.

Some of the highest levels have been found in the foods that are sprayed right before harvest, including like garbanzo beans and chickpeas, oats and wheat.

What Glyphosate Is and Why It Matters

And so wheat toxicity, I think, is, glyphosate's a major cause of the celiac epidemic we see in gluten intolerance today. So it's really, the government thinks it's perfectly safe for humans.

They don't bother to test to see how much is in the food. Others have tested, various environmentally conscious advocates. And Canada has done an extensive testing under pressure from a friend of mine, Tony Mitra, who has been an advocate for a long time.

He got them to test thousands of food samples, both in Canada and imports from US and other places, and they

found consistently highest levels of glyphosate in the foods from United States and Canada.

So it's in the food, which I think is the major source of toxicity, but it's also sometimes in the water supply, sometimes in the air, nanoparticles in the air, these are other sources of exposure.

So we really can't avoid glyphosate if you live in this country. Very difficult to find a place where you can avoid it completely. And of course, the government thinks it's safe and therefore they're not worried.

I think it's not safe. I think it's extremely not safe. And you can read my book to find out why. – Well, let's talk through a couple of the reasons why.

So you have described, in your papers, that glyphosate does cause proteins to misfold. And so when we think about tau proteins and, right, there are things that are, there are proteins in the brain associated with dementia, and then we have glyphosate that looks a lot like glycine, which is one of our amino acids, and so just walk us through step-by-step why that can be problematic.

– Absolutely, and this is what I think is the very critical, insidious, cumulative toxic mechanism of glyphosate that makes it harder to spot because it's slow and it accumulates over time.

Very, very dangerous. Glyphosate accumulates in the tissues. And I have a whole chapter in my book explaining the evidence that I see for this idea that glyphosate actually, by mistake, is taking, by the enzymes that assemble proteins, they mistakenly pick up glyphosate when they mean to get glycine and they put it into the spot where glycine is supposed to go in the protein.

If this is true, it's devastating in terms of the potential consequences of it. And I identified in my book a specific, what I call a glyphosate susceptibility motif that certain proteins have an increased likelihood of choosing glyphosate over glycine in certain spots that turned out to be extremely important for that protein's function.

So I've actually been able to identify a set of proteins that would be predicted to be susceptible to this kind of substitution of glyphosate for glycine that would cause them to misbehave in dramatic ways.

And in particular, think of tau in Alzheimer's, phosphorylated tau. Tau has some 80 places where it can be phosphorylated. And phosphorylated tau is highly associated with glyphosate.

When it gets phosphorylated, it doesn't attach to the cytoskeleton; it gets into the cytoplasm and becomes very toxic. It's associated with Alzheimer's.

I wrote in my book about the evidence that would support that if you substitute a certain glycine in the place where it binds phosphate, the enzyme that puts the phosphate on the tau, these are called kinases, and there's lots and lots of them that put phosphates on things, kinases are very important enzymes in the body, and those kinases can be predicted to be overzealous in yanking the phosphate off of the ATP.

And since that's a limiting step in the protein, they're gonna be overzealous in phosphorylating things. And on the other side, you have the guys who take the phosphate off, the dephosphatases.

And those also have a particular glyphosate susceptibility motif that's gonna disrupt them so that they can't take the phosphate off. So the combination is excessive phosphorylation systemically.

And certainly in the brain, tau phosphorylation is going to be a big problem. So that's one aspect. Then you have the amyloid beta, which is the misfolded protein that accumulates in the plaque.

And amyloid beta has a unique motif, a Gxxx/GxxxG motif, that is characteristic of, of what's called prion-like proteins. And that motif has been, that spot in the protein has been identified as the place where the vulnerability is to misfolding.

So normally, amyloid beta makes these alpha helices that then goes into the membrane. But with that particular sequence, it's disturbed. In fact, they've shown experimentally, if you substitute for some of those glycine, the Gxxx/GxxxG, that's three glycines.

If you swap out glycine for something else, it will disrupt its ability to form the alpha helix and cause it to form a beta sheet instead, a soluble beta sheet, which then gets into the cytoplasm and eventually enough of those to accumulate, they clump together and they form the plaque.

So I think there's a direct hit on both the tau and the amyloid beta connected to Alzheimer's exposure, connected to glyphosate exposure to then induce Alzheimer's.

– And so clinically, I'll just say this is anecdotally, right? I haven't done a controlled trial on this. However, I see patients with severe ALS, Parkinson's, dementia in my practice and, although not all of them, many of them have very, very high levels of glyphosate that we test on labs.

And when I see a glyphosate, the normal range is below.35, 0.35. And on this test, sometimes I'm seeing people at six and seven, and really, really high levels.

The typical person, who I see, that's relatively healthy, certain my glyphosate levels are below one, but over 0.35. Because as you said, it's so ubiquitous, it's really, really challenging to avoid.

– [Stephanie] It is. – And even when you're eating 100% organic. However, we still wanna encourage people to make these decisions to try to avoid as much of it as possible.

Protein Misfolding, Tau, and Amyloid

So for a layman, I wanna make sure that everyone's picking up, you're this super, super smart, MIT PhD, and so I wanna make sure everyone's understanding that essentially what's happening is that amino acids are like, I think of them like strands on a pearl, on a string of pearls, and then you get a peptide which is your strand of pearls but the pearl itself is an amino acid.

And then when we start to fold that strand of pearls together and we make a structure, like a 3D structure, that's a protein. And these proteins, they only work if they are folded in the right ways.

And so what Dr. Seneff is describing here is protein misfolding that happens when glycine, one of these pearls, one of these amino acids, is subbed out, there's a substitution for glyphosate because there's glyphosate in our bodies.

And that leads then to protein misfolding, which can be associated with dementia, directly associated with dementia potentially. Is that right? – That's beautifully said, that's very elegant, and that's correct.

And I just wanna point out that glyphosate is a complete glycine molecule. It just has, it's actually a pretty simple molecule relative to some other poisons that are in our environment.

A complete glycine molecule, except that it has an extra methylphosphonate unit attached to its nitrogen atom. And when the proteins' assembled, the nitrogen has to stay, you have a socket that perfectly fits glycine.

Glycine is the smallest amino acid. So if you can, if the protein can make a socket that's crowds out all the other amino acids, only glycine fits, that's how you make, make it specific to glycine.

But the nitrogen has to be outside of that socket 'cause it has to hook up with the paper dolls that are connecting up. So the nitrogen can afford to have this extra bulky piece on it as long as there are sort of small amino acids nearby.

And so that's a constraint. If you have another glycine to your left, you're especially vulnerable to glyphosate. Or if you have an alanine, which is also a very small amino acid, you need to have room for that methylphosphonate

outside of the socket.

But the socket fits beautifully. Glyphosate matches perfectly in the spot where glycine is supposed to go. So it's just the issue of the constraint of the extra bulk of the piece that's attached to the nitrogen that might prevent it from happening in certain circumstances.

If it was too big amino acid next door probably, it probably wouldn't fit. But I can understand, I can predict the circumstances where it would be encouraged to go, particularly if there's a binding to something like phosphate.

The enzyme, when the enzyme bonds, binds phosphate at that site where the glycine is highly conserved, which many enzymes do that. Phosphate has to fit in the substrate.

So that gives you the room for the methylphosphonate, which is about the same size as phosphate. So those are the critical ones, the ones that bind phosphate at a place where glycine is highly conserved.

That's my glyphosate susceptibility motif. And I've shown that several enzymes that match that motif have been shown experimentally to be suppressed by glyphosate.

– I wish we had a whiteboard so we could draw all of this. But I'm sure there are diagrams in your book, so I will refer people to that. Tell me a little bit more about your background because it's a little unexpected, right?

You are, essentially now, an advocate against glyphosate in the environment and you are associated with MIT, but your background it's biology, it's electrical engineering, there's computer science, artificial intelligence.

And maybe it's this unique background that gives you this unique perspective, but tell me, connect the dots a little bit for us. – Yeah, I've wondered whether my computer science training has allowed me to look at biology in a different way from what the way a biologist might look at it.

It's possible that that's the case. I've always been fascinated by biology. And computer science turned out to be a very convenient choice for a career path.

And I enjoy the work I did with writing a lot of code to some produce systems where you could communicate with a computer using natural speech precursors to Amazon Echo and the iPhone, Siri iPhone.

So those two products now, we did the very early work in that space, which was really exciting and I enjoyed it. I got concerned about autism around, I was concerned about autism for a long time, but especially around 2005, 2006, 2007.

I saw the rates going up every year and I was frustrated that the story was genetic. It's just this genetic susceptibility and need to find which genes that are, that aren't being affected, genetic mutations.

Very few people, very little money was being put into looking for environmental toxins that might be associated with the autism. So I wanted to do that.

And I just used my skills in sort of data analytics, looking at trends in diseases. And I worked together with Nancy Swanson, Dr. Nancy Swanson. She's a physicist.

So both of us are sort of more into the mathematical space of being able to do statistical analyses and look for significant correlations, and just grabbing data, readily available data from the web on disease trends over time, and then looking at chemicals in the environment that would also be going up dramatically.

And glyphosate was just a home run. I mean, it was just amazing. I was looking at lead, lead was going down. So lead probably is a contributing factor to autism, but it's not the one that's causing the epidemic.

So that kind of thing, eliminating things because they weren't going, trending the right way. But glyphosate going up

dramatically over time exactly, perfectly in step of the rise in glyphosate, rise in autism in the children.

And also, by the way, with the rise in Alzheimer's. Alzheimer's has also been going up dramatically over time. Exactly, perfectly matched to the rise in, rise over time of glyphosate usage on core crops.

And a long list of other diseases too, many of them are neurological, neurodegenerative diseases. – So this creates correlation in time. And what are the next steps that we would need to take to kinda move the scientific community and the government like, as you mentioned, the government doesn't think that this is harmful.

So in order to prove causality, what would we need to do? – Yeah, exactly. Well, that's what I was thinking. Correlation doesn't mean causation. They were screaming that at me.

Correlation doesn't mean causation. Lots of things are correlated, who cares? And so certainly it's a first step. If it's not correlated, it's probably not the cause.

So you can eliminate it. But if it's correlated, now you wanna look more deeply. So I got really interested in glyphosate because of its perfect match.

Nothing else was matching anywhere near as well. And it's pervasive. It's in the food supply. It's something kids eat a lot of the processed foods that are highly contaminated with glyphosate.

So it made sense to me that they were being exposed. And of course, I immediately identified the gut issue. And gut dysbiosis is a big deal now. Lots and lots of papers are being published on the gut problems that people are having, and the link between gut dysbiosis and disease.

Like for example, Parkinson's disease is very closely tied to gut dysbiosis, and gut problems, and autism is too. I was seeing from, I was reading all about autism and I saw that, I really had reached the point where it's gotta be something in the gut, it's gotta be something in the food.

So something that you're eating, because it's the gut, and getting to that point. And it just happened to be serendipitous that I heard a lecture in a conference that happened to be on glyphosate.

And I didn't know the word at that time, This was like in 2012. And I was blown away by the lecture because it was so, it matched so well with my understanding of what was going on with the autistic kids in terms of the glyphosate disrupting the gut microbiome and then that's causing different metabolites to be produced by the pathogens that are then affecting the brain.

Glyphosate, Gut Health, and Sulfate Disruption

And also, the disruption of the minerals, iron, and zinc, and manganese, and cobalt, these minerals were being grabbed by glyphosate 'cause it's a very strong chelator.

And therefore, the gut microbiome was not able to get enough of these minerals to be healthy so it became very imbalanced. And you could see from studies on glyphosate in which microbes it affects.

Those are the same ones that are depleted in association with autism. The ones that are robust against it are the ones that are overgrown in the gut, in the autistic gut, like these clostridia species that were producing toxic metabolites that are then affecting the brain.

And then there was also this issue of sulfur, which I really grabbed onto early on in my study of autism. I appreciated that the autistic kids have a problem with sulfur.

They don't metabolize it correctly. And in particular, they basically flush sulfate through the urine and have insufficient sulfate in the blood and throughout the body.

Something wrong with sulfate. I zeroed in on that early on. And by the way, that's also true for Alzheimer's. Very, very interesting. I've been studying, I read a whole bunch of papers by Professor Han, H-A-N, and colleagues at the Washington University in St. Louis, Missouri.

I think this go back to 1990s. And they noticed a severe deficiency in sulfatide in the brain in connection with Alzheimer's disease, which was very fascinating to me.

Sulfatide is the only sulfonated sphingolipid. And so I was very, very interested in, I had gotten interested in cholesterol sulfate to begin with in the autistic kids.

There's a condition where you have a genetic mutation that you can't get the sulfate off of cholesterol sulfate. And that condition is associated with a very high rate of autism.

So I suspected something about cholesterol sulfate being important. And then this sulfatide, which is this other sulfated sphingolipid. And so I got to think in terms of insufficient supply of sulfate to the brain as a consequence of impaired enzymes in the process of getting the sulfate to the brain, making the sulfate, hooking it up to something, traveling in the blood, unhooking it, I had to get to the glycocalyx, all these steps involve enzymes that bind phosphate, sites where glycine is highly conserved.

Pretty much all of them. So I think the glyphosate is wrecking the entire sulfate system in a big way, and that all of us are deficient in sulfate systemically in this country, I suspect.

I bet you, every one of us has a deficiency in sulfate, and sulfate is so, so important for so many things, yeah. It's just amazing to me. – So sulfate, there's so many directions I wanna go here.

But one, I had never heard that glyphosate was a chelator, and so that sounds like it directly affects the microbiome in the gut. But then you can start to think about second order effects, and third order effects.

That if we're not absorbing minerals, well, now we don't have cofactors for mitochondrial function, for neurotransmitter synthesis, for neurotransmitter metabolism.

And so you can see how these are going to, well, I guess, indirectly, but very quickly start to affect the brain, mood, like you're saying, autism, neurodegenerative disorders.

And one of the themes I hear you kinda sharing here is that what you found was true for autism is also true for dementia quite common. – [Stephanie] Exactly.

– And so it's like autism is also almost a dementia earlier in life or dementia is almost like an autism as we age. I'm curious about this, I wanna break down the sulfatide, and you are clearly a chemistry expert.

So sulfa, like our sulfa, our antibiotics, and then you've got like sulfites in wine, and then you've got people who have sulfur allergies or sulfur sensitivities, and then I hear you saying, there's probably an epidemic of sulfate deficiency.

Did I say the right one? – You did, sulfate deficiency. Sulfite toxicity and sulfate deficiency. And that's because these enzymes that carry the sulfate along, take sulfur, make sulfate, and go on to move, and move the sulfate around, you basically have to, sulfate's interesting 'cause you have to, it's hard to transport.

You have to hook it up to something, typically in a molecule with rings, with these rings, like these benzene rings. You hook it up to one of those molecules and you ship it out, carry, being carried by one of those molecules.

And then when you get to some destination, you drop it off. And you typically can drop it off in the glycocalyx. And the glycocalyx is this complex sugar, complex sugar structure that lines all the blood vessels.

And they are populated with heparan sulfate, chondroitin sulfate. These sulfated glycosaminoglycans. They have

big names. But those glycolipids (mumbles) attach to lipids as well.

I mean, it's all connected together with this stuff that makes structured water around it. So the gel water turns out to be a critical, critical aspect of biology that is created by those sulfates that are attached to those glycolipids, glycoproteins, and glyco, all these glyco things that have these sugar chains attached to them.

And when there's not enough sulfate, there's trouble. – Is this like "The Fourth Phase of Water" that– – It is, it is exactly that. And I read both of his, he has two delightful books that are meant for the lay public.

And they're really great with a lot of diagrams and things. There's "The Fourth Phase of Water," and then there's "Cells, Gels, and the Engines of Life." Both of them are excellent books that Gerry Pollack has written.

He's a friend of mine. And I certainly have followed his work and this whole concept of the importance of sulfate. In my opinion, sulfate's critical for maintaining the structured water.

And the gel water creates the battery. If you've read his work, it creates a battery. It drives proteins out and ends up negatively charged. And it's also this sort of like, almost like liquid, I call it liquid ice.

A very structured water that it has exclusions on water, keeping things out. And that means that all the stuff that's running around in the blood is not gonna affect the blood vessel wall because of this shield that's made out of water, but is only maintained because of those sulfates.

So when you don't have enough sulfates, the shield breaks, the cells get exposed to oxygen and glycation damage, all these things, then they get broken.

You have injury of the vascular wall, which then of course causes all kinds of things. – So would you know of good food sources of sulfates? Not wine, right?

Not sulfites. But how do we (audio skips)– – Right. – [Heather] More sulfate? – Well, that's the issue. Because sulfate, as I said, sulfate doesn't travel well by itself.

So the critical thing is to have sulfate carriers. And there's a lot of those. For example, tryptophan. Tryptophan makes serotonin. And tryptophan and serotonin are both sulfated when they're shipped around.

All of those neurotransmitters are sulfated. You have serotonin, melatonin, dopamine, adrenaline, all of those are sulfated in transit. And of course, cholesterol is also sulfated, and I've written a lot about cholesterol sulfate.

I believe it's critical both for heart disease and for autism and other neurological diseases. Cholesterol sulfate is a fantastic way to ship around both cholesterol and sulfate.

And when you can't make cholesterol sulfate, you've got a big problem because you're gonna have a deficiency in both of them. Cholesterol has to be packaged up inside lipid particles.

And those lipid particles actually depend on cholesterol sulfate in their membrane to keep them safe in the blood. So we have this whole thing with the elevated serum, LDL, the LDL is the so-called bad cholesterol and you've gotta take a statin drug 'cause your LDL is high.

And actually it's those small dense LDL particles that are especially damaging because they get oxidized, they get glycated, and then they cause inflammation in the artery wall.

And that can be in the heart, as well as in the brain. So anywhere actually. Inflammation in the artery is gonna cause inflammatory diseases of all sorts.

And so it's all, I think, because of insufficient sulfate in the membrane of the lipid particle that doesn't allow it to be protected from oxygen and sugars that are just traveling in the blood, and causing trouble. – Is there a role for

glutathione here, because that has a sulfur group and then also as an antioxidant.

– [Stephanie] Absolutely. – Yeah, what do you see the role of glutathione being here? – Essential, essential, and also problematic because glyphosate is disrupting.

And of course, glutathione has a glycine, I don't know if you know that. It's three amino acids stuck together. So tripeptide it's called. And it has glutamate cysteine, which is a sulfur-containing acid in glutathione, and then it has glycine.

And I'm suspecting that it's getting glyphosate substituted for its glycine because glyphosate causes an increase in the liver. They've shown in studies with rats that it will cause the liver to produce excess amounts of an enzyme called gamma-glutamyl transpeptidase, GGT.

And that enzyme is quite interesting because it takes glutathione apart into its individual amino acids. It undoes the glutathione molecule. And I suspect that it could be that incorrect versions of glutathione are making, are getting made that have glyphosate instead, and therefore they have to be disassembled, try again to hope not to get glyphosate next time.

That could be a reason. – We ran GGTs on most patients as a sensitive liver marker. And so what I hear you saying is that an elevated GGT could indicate a lack of glutathione or at least a glutathione that wasn't going to be as productive.

– It'll do, it'll remove glutathione. It'll deplete glutathione 'cause it takes glutathione apart. And I think its elevation is an indicator of glyphosate toxicity, it could be.

I mean, other things can cause elevated GGT as well. But it is a very good marker. It's good marker of a lot of things, even cancer. I wrote a whole paper on GGT together with a colleague and it's quite interesting.

And it's an excellent marker of liver disease, even heart disease, cancer, a number of things. I don't know about Alzheimer's, but– – Can we take glycine to help to get rid of glyphosate?

– I think so. A lot of my practitioner friends are recommending glycine and finding that it's working well for their patients, to take glycine as a supplement and certainly to eat glycine-containing foods.

One thing that's good is organic beef, beef broth, bone broth. Bone broth is, I think, a very healthy nutrient because it has a lot of good things in it, including minerals, but it also has glycine, because there's tons of glycine in collagen.

And this is another thing that I've, I'm concerned about, is collagen. Collagen is the most common protein in the body. It's something like 25% of the proteins in your body are collagen molecules.

And collagen is a glue. That's what's in your joints, in your bones, in the tissues, sort of the in-between stuff of your, that holds you together is collagen.

And collagen has a long, long sequence of GXY, GXY, GXY, GXY, where every third amino acid is a glycine, extremely glycine-rich protein, which makes it extremely susceptible to glyphosate mischief.

And I think a lot of the things we're seeing so many people suffering from, bone pain, and joint pain, and back pain, issues with their elbows, and knee replacement surgery, and hip replacement surgery, we see all these people hobbling around as they get, as they age.

And I think there's accelerated aging in that respect, and physical disability because glyphosate is messing up the collagen. It's gonna be cumulative over time.

So it's gonna get worse and worse as you age.

Sulfate, Structured Water, and Glutathione

– And also, as you mentioned with kiddos who are eating a lot of wheat-rich food, high in glyphosate, the same thing happens to our elders, right, when we ship them off to these memory care centers or senior living facilities where they're in front of TVs, having cereal for breakfast, pasta for lunch, and sandwiches, and ice cream after dinner, right, that we're just feeding them more of the toxicity, not just the sugar, but with these GMO and glyphosate-sprayed foods.

– Right, I think one of the most important things that any facility that's taking care of Alzheimer's patients should do is to switch their diet to a certified organic whole foods diet.

I think it would be the best thing you could do for those patients. And of course, they're not doing that. Oh, you do that, right? – Yeah, I have a residential care facility for the elderly and that is exactly what we do.

– [Stephanie] That's marvelous. – We have an organic ketogenic diet as our base diet. – That's fantastic. And ketogenic is also extremely interesting, and I'm aware of the benefit of ketogenic.

In fact, I remember coconut oil was being recommended, and that's an interesting oil. I looked into that some time ago actually 'cause I had heard about coconut oil.

There was a woman who had the story, I think, about her husband. And so it's an interesting oil because the coconut oils are medium-chain fatty acids, not long-chain, not short-chain, but medium-chain.

And long-chain fatty acids get packaged up, they get packaged up in chylomicron, and they get shipped through the limb system, and finally they arrive to the heart actually.

The heart gets first dibs on them. And the heart loves that. The heart actually loves fat. It's funny how we think high fat diet is bad for the heart.

It's the opposite. High fat diet is good for the heart, because fats are really healthy fuel. I'm getting a little bit distracted here, but the fat that's in the coconut oil is medium-chain fatty acid.

It actually gets sulfated in the gut, and then it gets shipped directly to the liver. It doesn't go into the chylomicron. It is supplying sulfate to the liver, which is so important 'cause our liver is really, I think, grand central for sulfate distribution.

– Wow, so coconut oil is a way to, as in something we could eat that would (audio warps) more sulfate. – Exactly, help you to get sulfate levels up. So I think that's an interesting reason to take coconut oil.

– So there is some conversation around APOE4 and saturated fats, now you understand the chemistry very, very well, and there's a connection between sulfates and APOE4.

Can you, again, help us connect those dots? – Very, very interesting. And this is, I mentioned that this Han, Professor Han, Washington University, sulfatide, he found, they have found extraordinary things about Alzheimer's.

And it kind of annoys me that their research is not being picked up as far as I can tell by others 'cause it's really amazing research. Sulfatides are hard to work with.

So I think a lot of people don't choose to research sulfatide because they don't quite understand how to do it. But their group was highly skilled with analyzing the sulfatide levels in the brain.

And they found Alzheimer's disease was associated with 90% reduction in sulfatide in the gray matter early, at the very beginning of Alzheimer's or even before the Alzheimer's symptoms appeared, already 90% reduction in sulfatide in the gray matter, which is sort of the neuron bodies.

Sulfatide also was depleted in the white matter, which is more of the sort of myelin sheath. There's lots of sulfatide in the myelin sheath. But there's also sulfatide in the lipid, what do they call it?

Oh shit, I lost the term. These are special areas in the cell membrane that are concentrated with sulfatide in the neurons. And sulfatide is very important for neuron health.

And what's happening is that the immune cells, so there's inflammation in the brain and the immune cells are actually stealing the sulfatide from the brain, from the brain's system, from the brain cells, and depleting the sulfatide in the brain.

They're stealing it. It's very, very interesting. And I suspect they're stealing it because they need it too and they're deficient. I think your immune system is really God in your body.

If your immune system's not working, you're gonna just die of some infection. So it has to take priority over everybody else. And it knows how to go in and steal stuff.

So it'll just go right in there and help itself to the sulfatide because the immune cells need the sulfatide to stay, to stay healthy. And so I think that's really, really fascinating.

And the thing is APOE4, he did a lot of looking at the, he had these really highly, highly sophisticated experiments where he made all these different kinds of mice.

They can do lots of weird experiments with mice, where they get them to make human proteins. And they were able to make mice that had defective APOE4, that had excess human APO2, APO3, APO4 and compare all of them with each other.

And they found that the mice that had this human APOE4 in particular had severely depleted sulfatide in their brain. It took away the sulfatide. APOE4 is involved in this stealing of the sulfatide and it does it much better than the other APOEs, which means, which to me means central to Alzheimer's, is sulfide deficiency as a consequence of the stealing of the sulfatide by the immune cells from the brain.

– There also seems to be a role with APOE4, four especially, and fat metabolism or cholesterol metabolism. Do you have any insights there? – I looked into that first actually.

I was very interested in APOE4, and I've written some papers about it, as well as some blog articles about APOE4 and its connection to cholesterol metabolism.

And these things are complex and it's sort of hard to get the answer to. I think that what I found was that APOE4 facilitates the extraction of cholesterol from cells.

And in particular, I think it, actually I think was allowing the cholesterol, I'm actually forgetting. I remember reading about this some time ago, but I forget the details.

I think it was bringing the cholesterol into the blood, but in an odd way, like not in the normal way. So something, it's very hard. I think the real answer with APOE4 is with the sulfatide, not with the cholesterol.

That's my opinion. – Interesting, yeah. I'm talking to Dr. Steven Gundry and he's written extensively also about this. So I'll get to have both of your opinions here, and it's really appreciated.

I have so much curiosity. You have put yourself out there as an advocate for the environment, for health and there's a lot of criticism that comes with that.

And I think I'm, I'm beginning to also be in a place where there are people who are highly critical of the work that we're doing around dementia. And so I'm just wondering almost at a personal level, like how do you get through it?

– Yeah, I just basically ignore them. I feel privileged if they're gonna attack me because they're gonna make me much more noticeable to everybody by attacking me, right?

And I just basically ignore them. I'm like, "Fine. If you wanna tear apart my work, that's fine." I made it to science. I wanna figure it out. I wanna understand how biology works.

And these chemicals, these toxic chemicals are actually a great window into how biology works by virtue of how they mess it up. You would never have discovered these things.

How the biology is supposed to work if you didn't have these toxic chemicals to cause it to work incorrectly. That gives you tremendous evidence and tremendous information.

That's valuable for figuring out biology. And I'm just absolutely fascinated with biology, that's where I'm centered. I wish I could just hold up in a room and read about biology all day long.

But I find there's urgent messages that I want to get out, 'cause I just can't stand the fact that these kids have so much autism. It's gonna get worse.

It's up again this year. Hardly even any news about it. Every are rising. Nobody seems concerned. I just don't understand that. I think it's like, gosh, one in, I think it's even 1 in 40 something now, kids with autism.

APOE4, Cholesterol, and Alzheimeru2019s Risk

It's just astonishing. – There's the argument there, I'd be curious to your insights, that we've gotten better at diagnosis, it's not actually that incidents is going on?

– I hear that all the time and it makes me very angry. – I bet. – 'Cause it's just not true. When I was a child, I never knew anybody with autism and nobody within the autistic symptoms.

Nobody, it didn't exist. We didn't have the word in our vocabulary. And now you find autistic kids very easily. Almost everybody knows somebody who's got autism or somebody in the family has autism.

I mean, it is so around. – By multiple people in the family, yeah. – Yes, multiple people in one family. It's just so obvious that there's more. And I find it really annoying that people can explain away these problems this way, by saying, "Glyphosate.

Oh correlation doesn't mean causation." And to say, "Well, oh yeah, we're just diagnosing it more." I mean, all these sort of excuses to not look at the problem squarely in the eye and say, "What is going on here?" – Well, there's also Seralini out of France, am I saying his name correctly?

– I think so. – Again, I usually read it. I don't say it. He's been targeted quite aggressively. And so there's, not only this, it's convenient, right?

It's inconvenient to avoid glyphosate. It's work. You have to spend more on your food. You have to go out of your way to make sure that whatever you're eating is organic or wheat-free.

It just takes effort. And then when you look, so that's one thing from a public kinda consumer side. And then from a researcher's perspective, no one is, thank God you are, but there are very few people who are motivated just to find the truth, right?

There's financial interests, there are– – Absolutely. – And also, there's an interest in avoiding being so targeted. And so yeah, I'm curious your experience with that.

– Now that's certainly true. I feel like most people, if they're trying to keep an income going, they don't wanna go near a topic that's controversial, especially if pharma doesn't like it.

And a lot of the funding for the agricultural universities comes from the chemical industry. So don't bite the hand that feeds you, right? You're not gonna look at glyphosate if Monsanto's the one that's funding your research.

So they're very clever to just fund the research so that you won't go near their product and keep their products safe from it, from observations about what's bad about it.

So it's really, really sad that way that we don't have enough independent researchers who are not beholden to the industry, particularly pharma of course.

Pharma has a huge reach. And they control even the journals so that it's hard to get something published if it's gonna tear down some expensive pharma drug that's making a lot of money.

Nobody wants to go there if they wanna continue to get their funding. So I think that's a huge, huge problem. Pharma has too much money, and they use that money to control the messaging.

And they fight very hard against anybody who steps outta line and starts saying that their product might not be so safe. And of course, the agrochemical industry is almost the same thing as pharma.

Bayer now owns Monsanto. So it's all one big package of chemical toxicity, in my opinion, that is sort of being thrown at us. As an individual in a society, it's extremely hard to stay safe from these chemicals and live a healthy life.

– And I think it's important for people to understand that context, that it's not, it's so much more convenient to just explain it away, to say correlation isn't causation.

But if they understand that, well, it's really challenging to link causation to do the research because of how, again, like how society is set up, how the dollars flow, who's funding what.

And so understanding that, I think, can help us to sort of motivate. 'Cause really when I hear, when I read your work, when I hear what you have to say, it's very common sense, right?

Like when we have new chemical that is very similar to some of the chemicals in our body, it can substitute for it and it can cause misfolded proteins, it can jam up our biochemistry.

That makes perfect sense to me. There's nothing about that that doesn't make sense, right? But then you go to the next step of, "All right, well, how do you prove causation," and you see that there's this roadblock in doing any of that.

And so then you just kinda say, "Okay, well then let's just go back to common sense.

Criticism, Research Barriers, and Industry Influence

" – And I think that in time, if you just have people like your patients who carry out this sort of healthy lifestyle change and get better, that becomes extremely good evidence.

And a lot of people like you are busy as clinicians, you don't have time to sort of set up a controlled study with a placebo group and all that kind of stuff.

You wanna just heal your patients. And if you do succeed in healing them much better than the next person's healing their patients, people are gonna stand up and notice that, right?

– Certainly, I hope so. We're publishing our trial on dementia this year. And a big part of that was suggesting that everybody in the trial get on an organic ketogenic diet.

– Perfect. – Yeah, Dr. Bredesen also published his trial last year, showing the reversal of dementia on about 75%

of participants. And part of that was avoiding, certainly avoiding these high glyphosate foods through a ketogenic diet.

So yes, we're starting– – I'd like to, yeah, go ahead, continue. – We're starting to put the pieces together. – Yeah, it's great. And I wanna say something about ketogenic diet.

This is something that I've gotten interested in in the last couple years. I don't know if you have heard of deuterium. Do you know what deuterium is?

– [Heather] No. – Oh, okay, great 'cause you will love this. I got approached by Laszlo Boros, Dr. Laszlo Boros, who was, he's from Hungary. He was trained at the Szent-Gyorgyi institute, and he has a medical degree, and he got interested in deuterium a long time ago, and he introduced it to me in December of 2019, I think it was, yes.

And I was immediately really enthralled by it and grabbed hold and took off with it, because I could see how it would be connected to glyphosate very, very easily.

So it was just really, really thrilling. And I had a great, pouring over deuterium for a few months before COVID hit, and then I kinda got into COVID, and that kinda linked into deuterium too, so I've been really excited with the breakthroughs in my own research over the past couple of years in part because of COVID and just circumstantial situations that are opening up new windows to study things when you look at the COVID disease and how that, that's also, I think, connected to glyphosate poisoning, which is disrupting the immune system, and that also connects very, very directly to deuterium.

So deuterium is heavy water, heavy hydrogen. Hydrogen is the smallest atom. It's just one proton and one electron. Deuterium is a proton, electron, and a neutron.

So it's about twice as heavy as hydrogen. And it's present naturally in water at about 155 parts-per million, which sounds small, but actually when you look at the numbers, it's actually significantly higher levels of deuterium in the blood than there are calcium.

So some of these minerals are also much lower levels in the blood than deuterium. And deuterium turns out to have different properties from hydrogen, as you might imagine.

Because it's heavier, it sticks better, in binding, and then it's less likely to wanna hook up in these ionic bonds. So the covalent bonds are stronger, the ionic bonds are weaker.

And because it's heavy, it tends to stay in the liquid phase. If you evaporate, it'll stay in the liquid phase. So these different properties of deuterium relative to hydrogen cause different chemistry to happen.

And it turns out that the mitochondria really, really care about not getting deuterium, getting as little deuterium as possible into their intermembrane space.

They really care about that. Because deuterium is like a big bulky, the hydrogen, the proton motive force is what drives the ATPase pumps to make the ATP.

That's protons pouring across that membrane. They sort of, they pump protons into the membrane and then the protons naturally pull, come back out through these pumps, these ATPase pumps, and that is what makes the ATP, that's the energy behind the ATP.

So those pumps actually get kinda clogged up with deuterium if there's too much of it. It breaks them. And also causes reactive oxygen species because the whole thing isn't working smoothly anymore.

It's like an engine with sugar in it, sugar in the gas tank. – So how do we avoid deuterium? And what does it have to do with glyphosate? And is hydrogen water something that we should be considering?

– Good, all good questions. You can see how I got really excited when I saw this. I immediately realized, I started looking at the enzymes. It's actually really fancy biology that is involved with managing deuterium.

The body has this incredibly intricate system that involves a whole bunch of enzymes that know how to make sure their product contains hydrogen rather than deuterium.

They know how to select for hydrogen in the reaction. And in fact, one of them is lipoxygenase. lipoxygenase is an enzyme that modifies fats. And lipoxygenase is known to be nasty because it causes inflammation in the artery wall.

It causes inflammatory response because it produces these leukotrienes which are these interesting-looking modified fats that are signaling molecules that causes inflammatory response.

Well, the lipoxygenase is very, very good at pulling hydrogen out of fats and replacing, it takes away two hydrogens and replaces them with one oxygen.

And with those hydrogens, it's able to make deuterium-depleted water because it's extremely good at choosing hydrogen and not deuterium. In fact, the industry is promoting the idea of eating fats that are rich in deuterium because then the lipoxygenase won't react with them, which will reduce the inflammatory response.

It's a really stupid idea because you desperately need that deuterium-depleted water that that enzyme is making.

Deuterium, Ketogenic Diets, and Mitochondrial Health

I'm kind of getting ahead of myself 'cause there's a whole bunch of other enzymes that also are able to select hydrogen over deuterium. And many of those enzyme are ones that are affected by glyphosate.

So there's a whole class called flavoproteins. And flavoproteins have a particular site where they bind phosphate. Just as I said, they bind phosphate in two interesting molecules: NAD, nicotinamide adenine dinucleotide; and FAD, flavin adenine dinucleotide.

Both of those they're related to B vitamins. The NAD comes from niacin, and the FAD comes from flavo, bio, riboflavin, riboflavin, right? Those two B vitamins, B vitamins.

Yeah, so NAD, FAD, those are both phosphate-containing molecules. They bind to enzymes at places where they have highly conserved glycine. It's like a three-glycine unit characteristic motif at the binding sites for FAD and NAD.

Highly, highly susceptible to glyphosate substitution, which messes those enzymes up, which prevents them from doing their job. And then what happens is lipoxygenase has to take over.

Lipoxygenase doesn't have that, those features that make it glyphosate susceptible. And it's extremely good at choosing hydrogen over, even better than the flavoproteins.

It's a really interesting enzyme. Highly skilled to choose only hydrogen, not react with deuterium at all. That's why they can make these deuterium-rich fats that won't react with it.

It's the backup system once those other guys have failed, that's what I think is happening. So you're getting a lot of trouble with your mitochondria getting piled up with deuterium, breaking their ATPase pumps, releasing active oxygen species, not having enough energy 'cause they can't make enough ATP.

Mitochondrial dysfunction is connected to all kinds of neurodegenerative diseases. And I think it's directly linked to deuterium toxicity because the enzymes that would normally fix the problem are not working.

And the other really interesting thing about that is the sulfate, because the sulfate makes the gel water. The gel

water pushes out protons, but it pushes out many more protons than deuterons.

It holds onto the deuterons because they tend to stay in the structure. They're not as light, they're not as mobile, they don't leave as easily. So those protons that come out of the structured water are deuterium-depleted.

And I think they're fed directly into the cytoskeleton of the cells, directly into the mitochondria to supply them with deuterium-depleted protons. So the sulfate system is wrecked by glyphosate, that means you can't make as many of these healthy protons and these enzymes that directly deliver deuterium-depleted protons to the mitochondria are also disrupted by glyphosate.

So I think we have a national issue of deuterium toxicity as a consequence of glyphosate in our society. – You know, you mentioned, I've heard you mention inflammation and mitochondrial dysfunction, and I've been at conferences where someone will say, "Mitochondria dysfunction, this is the cause of everything," or, "Inflammation, this is the cause of everything." And what I really appreciate about your work is that what causes inflammation– – [Stephanie] Exactly.

– What causes mitochondrial dysfunction? And you take it that one step back and say, "Okay, these are the toxins that come into the system, and muck up this system, and then cause symptoms," and then, of course, like these diagnoses that are these Latin words that are really fancy and really important to some people.

The question then is how do we avoid them? We can't avoid them completely, but what do you do? You are one of the people who knows more than anyone about how toxic glyphosate is.

How do you avoid it? – I wanna first say the fats, because the fats are actually really good deuterium-depleted foods. It turns out that fats have low deuterium compared to other foods.

– Oh, this is a ketogenic diet. – Ketogenic diet. You're getting a low deuterium diet when you eat a ketogenic diet. And I think that's super, super important, that people don't realize that.

And Laszlo Boros has written about that in his, in published papers that the ketogenic diet is a low deuterium diet and that's why it's healthy. The other thing I wanna say is that the deuterium was first discovered as a toxin by the Russians.

And they had people living up north in Siberia, they noticed they were living a really long time, like they had a really high longevity and they were eating really kind of bad food.

I mean, they didn't get fruits and vegetables. They were basically eating meats and fats, animal-based foods. They weren't getting a lot of, 'cause they couldn't, they didn't have a growing season.

It was long enough to get the fruits and vegetables. And yet they were super healthy, lived to be 110, 112. And they were like, "What's going on with this?

Why are these people so healthy?" So people got interested in that, and some researchers finally chased it to deuterium-depleted water because glacier water is naturally deuterium-depleted, and that's what they were drinking.

And so then that's become a really interesting, it's been research out of– – How do I know? You're drinking glacier water. – [Heather] Well, it's spring water.

– Yeah, yeah, that's good too. Yeah, I like, I buy a Hawaiian volcanic water. And it's also good, it's got sulfur as well. Iceland has really good life expectancy, very low infant mortality.

Iceland, and they've got these volcanoes with all this basalt rock, that's a lot of sulfur, but it's also the glacier water which is giving them low deuteriums.

And they have both low deuterium and the high sulfur, which I think is what keeps them healthy. Those are sort of two critical things. The only two supplements that I take, this is right here, deuterium-depleted water, and Epsom salt baths.

Those are my only two supplements. – Interesting, interesting, okay. And then what about lifestyle? I worry about my patients who live in an HOA, right, where it's being sprayed and then their dog is out running around and rolling in, and then the dog comes inside and they're walking barefoot.

Avoiding Glyphosate and Closing Remarks

Or they're walking outside with their shoes on and then they wear their shoes in the house. Do you think, should I be worried? – I think you probably should.

And I don't know how to stop that, right? That's what's so frustrating, is people living next to people who are spraying. I mean, I've been contacted by people with, even like an organic farm and then you've got these farms all around you that are spraying toxic chemicals.

And how do you keep your organic farm more organic? It's just so sad that we have to really fix everybody before we can be healthy, right? We have to get everybody onto the agenda of converting.

I think the most important thing our country could do right now is to get rid of the mega farms and replace them with small family farms that are organic across the board.

Anybody who's young, starting out in life, buy some land, grow some food organically. – I was having this conversation last night when, talking about prevention, and preventing disease, and where do we start, what's the root cause, and, hands down, everyone agreed the food system.

Fix the food system. – Fix the food, yes. – So cheers to that. (both laugh) Thank you for doing your part. It's an absolute pleasure. And I'm gonna have to listen to this recording about six times to fully grasp everything that you just said.

And I've read your papers, highlighted, notes in the margin, and I didn't realize until I got your bio that you had a book. So first thing on my list.

– Yeah, I've got it right here. – Oh, show us. – I'll hold it up. "Toxic Legacy: How the Weedkiller Glyphosate is Destroying our Health and the Environment." – Thank you so much for making that available to people.

If anyone wants to understand more about what you're doing, about your work, where can they learn more? – I have a personal webpage, stephanieseneff.net.

It's a starting point. And I have a section there on my book and various links to various places, you can buy my book, as well as interviews and papers that I've written.

And it also points back to my MIT webpage, which is a longer thing, but it's got, my MIT webpage has tons of stuff. All my papers are available there, all my published peer-reviewed papers on my MIT website.

And if you just search my name, even probably just Seneff, you'll find some people who are claiming that I'm kind of a wacko, but you can ignore them.

There's lots of interviews that you could find just by searching Stephanie Seneff or even just Seneff. It's a very rare name, S-E-N-E-F-F, and you'll find interviews.

I've done lots and lots of interviews, and also presentations. – Well, thank you for doing this one. And if you're a wacko, then I will join you. Searching for truth, and also for using common sense.

Thank you again so much for your time. It's supremely valuable, and I just couldn't be more grateful to be joining this fight with you to help people live healthier lives.

– It was really my pleasure. I enjoyed so much talking with you. And thank you for what you're doing to help the Alzheimer's patients, so important. – [Heather] Thank you.

(bright music)