Mind & Life Podcast Transcript
Robin Nusslock – How Stress Gets Under Our Skin

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Opening Quote – Robin Nusslock (00:00:04): *Biology is very dynamic. The more I study the biology of the human brain and body, the more I really begin to appreciate that it's molded and sculpted by experience, much more than I initially thought. And I really appreciate this insight because it challenges the deterministic, kind of static view that I think many people have of biology, which is that DNA is destiny and that there's these traits built into our biology that really determine our life outcome. And I'm just not seeing a lot of that as the evidence plays out. I'm really seeing a biological system that's very affected by life experience—across the arc of development and throughout the arc of life.*

Intro – Wendy Hasenkamp (00:00:45): Welcome to Mind & Life. I'm Wendy Hasenkamp. My guest today is neuroscientist Robin Nusslock. Robin is an associate professor of psychology at Northwestern University, where he studies brain systems involved in emotion and how those systems relate to health and well-being. He also studies how stress affects our brains, our bodies, our immune systems, basically how stress gets under our skin. And beyond just the biology, he's also very interested in life experiences and systemic factors that put people at risk for mental and physical health problems, and how we can work to remedy those situations.

(00:01:29) Robin joined us for our Summer Research Institute this past June, and I spoke with him shortly thereafter. We get into all these topics in our conversation. Plus, as you'll hear, Robin has had a long interest in the intersection of science and Buddhism. And along those lines, we also talk about his work with the Emory-Tibet Science Initiative, where he's been teaching science to Tibetan monastics and is now leading a program to involve them directly in research projects, both in the US and in India.

(00:02:00) I love how wide-ranging and synthetic Robin's approach is. He's integrating not just biology and psychology, but also looking at environmental and social and even systemic structural factors that affect our minds and our lives. He's thinking and moving research forward on all these levels, and I think this kind of holistic approach is really where we need to be going. Robin is such a clear communicator about all this too. It was really a joy to dig into these ideas with him. As always, if you're interested, there's a lot more of Robin's work in the show notes.

(00:02:37) And this episode marks the end of our seventh season! We'll be back in a few months. Meanwhile, you can always check out any episodes you missed or revisit your favorites at podcast.mindandlife.org. It's making me really happy to see that list of episodes growing and becoming more nuanced and offering more perspectives, hopefully giving us a better understanding of our minds. I really want to thank each of you for listening and for sharing episodes with folks you know who might benefit. And thanks to those of you who've sent us feedback. We've gotten some lovely notes recently

about how the show is impacting people's lives, which is amazing to hear. It really lifts our hearts. Okay. I hope you all have a wonderful end of the year. And with that, I will sign off for 2023. I'm so happy to share with you, Robin Nusslock.

Wendy Hasenkamp (00:03:35): It is my great pleasure to be joined today by Robin Nusslock. Robin, welcome to the show and thanks for being here.

Robin Nusslock (00:03:41): Oh, it's so wonderful to be here with you.

Wendy Hasenkamp (00:03:44): You have done so much interesting research in so many domains, and I'd love to hear a little bit of your path of how you got into studying the brain and emotion and stress, and also maybe interested in meditation or things in that direction as well.

Robin Nusslock (00:03:58): Yeah. Due to a variety of experiences during my teenage years, I just found myself becoming very interested in the mind—really how the mind works, and what the mind is. And at that point in time, I didn't really have an understanding of the methods of investigating the mind. So, I just found myself kind of exploring different traditions and different teachings. And my parents actually saw my interest in the mind, and my mom for a holiday president bought me Chögyam Trungpa's book, *Shambhala: Sacred Path of the Warrior*, and that was actually my first exposure to Buddhism. And then she proceeded to go to Blockbuster video and rent me Joseph Campbell's Power of Myth. And I would sit and take notes, and I think my parents kind of wondered, "Who is this kid?" *[laughter]*

(00:04:58) And that led me to a real love of Buddhism and the method of investigating mind through contemplative approaches, and this first-person investigative approach. And actually, then I went to the University of Wisconsin to major in philosophy and Buddhist studies. And Geshe Sopa was at the University of Wisconsin, and he created one of the first really true Tibetan Buddhist academic programs in the US. And so I felt very fortunate to be at the University of Wisconsin, and was greatly enjoying my experience there. And at the summer of my freshman year, I needed some money for the summer. And I saw an advertisement for scrubbing electrodes in a neuroscience laboratory. And I thought, "Well, this is great. I can listen to my music. I can scrub electrodes and I'll have myself a great summer."

(00:05:35) And unbeknownst to me, I had just walked into Richie Davidson's laboratory. And I was there that summer scrubbing electrodes, and on like, the third day I was there, Matthieu Ricard walks in. And throughout the course of my time that summer, I had this amazing exposure (albeit as an undergraduate research assistant) to a very different paradigm of investigating the mind than what I was familiar with at that point, which was more of a third-person investigative approach via science.

(00:06:05) And I knew in that moment that my life was going to change, and I have just so much gratitude to Richie in exposing me to this particular method of investigating the mind. And I finished my undergraduate work at the University of Wisconsin, majoring in psychology, and then did my PhD at the University of Wisconsin, working with Richie and others to really investigate the mind using the tools of neuroscience, but never losing my spark of interest in Buddhism.

Wendy Hasenkamp (00:06:33): Wow. It's so wonderful to see how those threads were there so early and have continued to weave across your life. It'll be great to dig into all of your work. I know you've been thinking a lot recently about the very relevant question of how stress in the world and in our lives gets under our skin and into our bodies, and how the brain's involved in that and lots of different systems in our body. So, I'd love to unpack that a little bit with you. I'm not sure where best to start

because everything is interrelated, but how do you begin to think about that, and where would you like to begin?

Robin Nusslock (00:07:10): Yeah. So, once I left graduate school, I have taken a very traditional academic path. I joined a Northwestern University as a assistant professor in psychology, and in neurobiology and neurology as well. And the defining theme of my work during the early stages of my career was really, how is it that the brain creates emotion? So, how does the brain generate our different emotional states, our highs and our lows, and our pleasures and our sufferings? And using the tools of human neuroscience with a focus on structural and functional brain imaging as well as EEG, I've really examined that work for the last 15 years or so. And that continues to be a very strong focus of my career.

(00:07:58) About six or seven years ago, I developed a very dear friendship and collaboration with a psychologist here at Northwestern named Greg Miller. And Greg runs a laboratory in which he looks at how stress affects the immune system. So how is it that stress affects immune cells that are involved in inflammation and immune signaling? And so, through our friendship over the last number of years, we were saying, well, let's really combine our interests and look at what we would call a neuroimmune network.

(00:08:29) So a neuroimmune network is interested in, how do the brain and body communicate with each other in ways that generate both risk and resiliency for mental and physical health problems? And embedded in that question the interest is, how is it that what's out in the environment gets underneath our skin, and embodies itself in our skin in ways that can put us at risk or resiliency for life's slings and arrows? And so, I really see this chapter of my career as taking a multi-systems perspective of health, a more holistic perspective of health, and really viewing both risk and resiliency for mental and physical health problems as being a full-body phenomenon, as opposed to just simply residing in one organ system in the brain or the body.

Wendy Hasenkamp (00:09:21): Beautiful. I love this synthesis. I really feel that this is where medicine and all approaches to health need to be moving. So, what are the various ways that stress in the world can get inside of us?

Robin Nusslock (00:09:34): Yeah. So, there's essentially a century of research showing that stress affects our health, and that stress can lead to various health disparities and outcomes and stress-related health problems. And so, this very interesting question is, how is it that stress gets underneath the skin to affect our life's trajectories and our life experiences?

(00:09:58) I would suggest that the first way station of stress in entering our brains and bodies is in the stress physiology in the brain, and particularly around the threat circuits in the brain. And the reason I suggest this is that the brain's threat circuits, particularly the amygdala, go through developmentally sensitive periods very early on in life. And this is based on both preclinical animal work and human work to suggest that very early on in life, we're basically trying to get almost a sense of the temperature of the room. How safe am I here? How much can I trust this particular place? And that really leaves a footprint on the stress physiology of the brain, centering around the amygdala and other stress sensitive brain areas. That, in a sense, teaches the rest of the brain and body about its subsequent development.

(00:10:50) We also know that life stress and adversity, particularly during the early days and years of life, affects the immune system. And inflammation is this kind of first response of the immune system to pathogens and wounds and various types of things. And it's absolutely critical for our survival, but when

it's chronic, it can essentially set the soil, or build the foundation for numerous mental and physical health problems across the lifespan.

(00:11:19) And so, this interesting question is, how is it that stress and the environment affects the brain and then the body? And decades of research have really established the anatomical pathway through which stress centers in the brain can communicate with the body in part through what's called the sympathetic nervous system. This body and brain system is really designed to create a fight or flight response, to help prepare us for any defensive situations we're encountering. And what's interesting is that when the brain's in a state of defense, it actually sends signals to the brainstem, which in turn activate the sympathetic nervous system. And the sympathetic nervous system descending from the brain synapses or connects on to many organs in the periphery, and releases a neurotransmitter called norepinephrine onto these organ systems, and really prepares our body for a fight or flight situation, increasing heart rate, increasing respiration.

(00:12:11) And one of the places it connects to is the immune system, in particular, organs where the immune system is developing—the bone marrow, the thymus, the spleen. And in releasing norepinephrine onto these early white blood cells, it actually directs the development of those cells towards a more pro-inflammatory expression, as opposed to an antiviral expression. And that's super adaptive in the short term, right? We want our brain and our bodies to communicate, to be in synergy with each other, to help us prepare for anything coming up in terms of threats. But when chronic, that can actually lead to chronic low grade and non-resolving inflammation. And this kind of mind body paradigm can really set the early foundation for stress-related health problems across the lifespan.

Wendy Hasenkamp (00:13:01): You mentioned the amygdala, and I just want to pause there for a minute, because a lot is made of the amygdala in relation to the stress response, and the "fear center," and all of this you hear in public discourse. And you recently gave a talk which I attended, and you were very nuanced, which I so appreciated, about the role of the amygdala. (And so, I was kind of in the back cheering like, "Yes!") So, it would be great if we could explore just a little bit of the complexity there within that system, because I think a lot of people know about the simplified idea of the prefrontal cortex and the amygdala—and sometimes it's almost made out like that's the entirety of the brain... *[laughter]* So, could you share a little bit more complexity there?

Robin Nusslock (00:13:47): Yeah. It's such a great question. One of the things that's so beautiful about neuroscience is that it's really defying our simplistic expectations and our simplistic understanding of what the mind is. And to me that's really exciting because it just highlights the fact that this organ, this mind is going to continuously be more complex than we thought it was going to be. And we're seeing that in the genome as well. When the human genome was mapped, we thought we would find the gene for disorder A, or life experience B, or health outcome C. And we're realizing that genomics is much more complex than a single gene leading to a single outcome. And we're seeing that in the brain as well, that what should be unified in the brain is actually quite distributed in the brain. What should be distinct in the brain is actually kind of mixed across multiple different brain systems.

(00:14:36) And so, the amygdala is maybe one of the best examples of this. So, we think of historically the amygdala being the fear center, right? So, researchers like Joseph LeDoux and others have done just amazing and pioneering work showing that the amygdala is involved in fear and threat. But one of the things that we're recognizing is that the amygdala, like many other brain areas, does many different things, and actually it responds to positive stimuli as well as to threatening stimuli. This is in part driven by the work of Kate Wassum and others at UCLA, who have done really elaborate research showing that everything we think about the amygdala could be also associated with reward regions.

(00:15:13) And it just highlights the fact that yes, the amygdala is involved in threat, and it's involved in defense. But threat and defense also involves coupling with motivational states and reward states and positive states and negative emotional states. And I think it's a humbling teaching for us in the field of neuroscience and psychology to recognize that we need to move beyond studying one brain region as the region that does this particular thing, and to recognize that it's going to be more complex than that, and that we also need to understand how brain regions communicate with each other, which is really going to be critical moving forward.

Wendy Hasenkamp (00:15:47): Thank you. Beautifully said. So, you were mentioning about childhood adversity and how really critical it is during early development, how things get "wired in" terms of how we perceive the world as safe or not, and what is threatening. And I've heard you mention also some interesting work about the relationship there too with the prefrontal cortex, and how that develops from early childhood in relation to experiences of trauma or things like that. Can you share about that?

Robin Nusslock (00:16:16): Yeah. So, here you've got a situation in which now the brain is... During the very early days of life, one of its primary challenges as I mentioned, is to really kind of say, "Well, how safe am I in this particular world? In this particular situation?" And so, these stress physiology systems in the brain really then appear to guide subsequent brain development of other systems.

(00:16:38) And one of the systems that these subcortical threat systems appear to really guide the development of is the prefrontal cortex. So, the prefrontal cortex is this piece of tissue right behind our forehead. It's an amazing part of our brain. It's a part of the brain that, unlike the amygdala, goes through a very protracted developmental arc. And the amygdala, I'm not saying that it becomes static at some point in time, but its critical developmental window appears to be quite early. The prefrontal cortex by contrast, is really fully developing into the late 20s. And these developmental mechanisms involve the reduction of synapses and the reduction of cells and dendrites, but also the production of myelin, which is this kind of insulation around the axons of our neurons that are really critical for prefrontal development. And again, we know that this continues through our late 20s. And so, by default that suggests that the prefrontal cortex is potentially the most influenced by life experience because it's the most open for the most protracted period of time across development.

(00:17:45) What does the prefrontal cortex do? Well, wow, it does so many different things. If I was a cognitive scientist, I would be saying it does A, B, and C. And if I was a developmental scientist, I'd be saying it does this or that. But as somebody interested in emotion, I'll focus on the fact that the prefrontal cortex plays a really critical role in a number of things. First of all, it really helps us guide our behavior in this tension between short-term goals and long-term goals. So, Robert Sapolsky, who's a wonderful writer on the mind and brain says, "The prefrontal cortex allows you to do the hard thing when it's the right thing to do." So, it kind of is, in a sense, a brake pad for just purely impulsive behavior. And it kind of projects into the future about what I want and how what I want in the future is compared to how I want now.

(00:18:30) And one of the things that's really important in that set of goals is to regulate other parts of the brain. And so, one of the things that the prefrontal cortex does is it actually has structural and functional connections to subcortical brain regions that may be more involved in generating emotions, and it regulates those particular regions. And regulation doesn't mean just quieting—it might amplify it, might maintain, or it might attenuate the activation in those brain regions, depending on what the goals are for that person in the particular time.

(00:19:00) And we know that stress and particularly growing up in adverse situations affects this process. And if anything, one of the insights is that growing up in adversity actually accelerates the development of the prefrontal cortex, and actually accelerates the wiring of the prefrontal cortex to the sub cortex—because, in a sense, a person is being forced to grow up too fast. And that wiring, actually it's saying, "Wait, we've got to navigate a complex scenario or we're going to grow up too fast." And that is actually associated with poor health outcomes mentally and physically. And so, it highlights the importance of letting kids be kids, because you want the brain to just kind of play and explore, before it grows up too fast.

Wendy Hasenkamp (00:19:44): Oh, that's really interesting. Yeah, because I feel like there's so much made of, we want to have our prefrontal cortex be able to regulate. And even that's part of what people think is happening with meditation, is engaging those systems. But I guess what you're saying is if it happens too early, then it can become maladaptive.

Robin Nusslock (00:20:03): Yeah. So, this is the work of Dylan Gee, who's done some really amazing studies of individuals growing up in really adverse situations, in which they were able to do brain scans. And what they found is that the kids who grew up in a really adverse situation during the early years of their life, the coupling between the prefrontal cortex and the sub cortex actually developed sooner than it should have. And the idea was that these kids were in an environment in which they either consciously or subconsciously knew that they weren't safe, and that they needed to become hyper-regulated. And we think of a lot of emotional problems as being problems of dysregulation, but being overly regulated also comes with its own consequences, and is associated with anxiety and particularly depression. And so, Dylan's done beautiful work showing this, that when you follow these individuals who in a sense grew up too fast, down the road they can have a higher risk for addiction and depression and anxiety.

Wendy Hasenkamp (00:20:59): That's really interesting. And then that's making me think also of your lab's emphasis on looking at reward systems. And so, do you want to say a little bit about how those play in, and can respond to adverse experiences?

Robin Nusslock (00:21:13): Yeah. So, we think of the amygdala as kind of the brain's brake pad—and I know I'm being reductionistic in saying that it's just that one region. But just for the conversation, I'll focus on the fact that one of the challenges that the brain has to do is decide, "Do I freeze and halt? Or do I go and approach?" And that's really one of the main decisions that the brain needs to make at any point in time is—do I go, or do I freeze? Do I stay, or do I approach? And so, stress systems involving the amygdala and the bed nucleus of the stria terminalis, and these other threat or stress sensitive brain regions can be very involved in pausing, inhibiting, and kind of freezing.

(00:21:54) But we have other systems in the brain that really facilitate approach and appetitive behavior, and these center in part on different nuclei, but per our prior point, these regions really communicate heavily with each other. One region that is very important for the acceleration or approach behavior is this brain region called the ventral striatum. And the ventral striatum is a fascinating hub of motivation in the brain. It involves the neurotransmission of multiple different processes. Dopamine is clearly important, glutamate is important. The opioids are really important, endogenous opioids.

(00:22:31) And this system is really has a number of objectives. One is to, if you see something you want, this system is very much involved in getting you up off the couch to go pursue that particular thing that you want. So, it's really an appetitive motivational system. So, if we think of the amygdala, extended amygdala, as the brake pad of the brain, you could think of this as the accelerator of the brain.

Another thing that this particular system is involved in is learning. So, what is it in our environment that predicts what I want? And so, learning is really important in this system, and this system has significant connections to brain regions that are involved in memory and other types of cognitive functions.

(00:23:14) And so, we've done a lot of work on this system. We've shown that this system is critical for appetitive motivation. We and many others have shown that this system is critical, has important implications in mental health, including depression and substance use. It's just a really interesting brain region and brain system that I think also has some really interesting confluences with Buddhist teachings.

Wendy Hasenkamp (00:23:41): Oh, really? Interesting. Can you say more about that?

Robin Nusslock (00:23:43): Well, one of the Buddha's main messages was that the pleasures that we seek in life evaporate quickly, and really leave us thirsting for more. And so, that the pleasures we seek in life are transient. And that was a very deep insight into the neuroscience of reward and human emotion. Because what's becoming apparent about the brain's reward circuits is that they're designed to habituate. That, from an evolutionary perspective, it wouldn't make sense for you to enjoy something and then not pursue it again. So, we almost have this hedonic treadmill that is embedded into our biology by evolutionary design to keep us striving and pursuing and going.

(00:24:30) And that makes a tremendous amount of sense from an evolutionary perspective, helping us navigate the challenges of passing on our genes to the next generation. But boy, that can create a lot of pain and suffering in the human mind as we wonder why, when we drink from the ocean, we might feel a momentary sense of satisfaction, but then we're immediately thirsty again. And I think that this midbrain dopamine system is very interesting in understanding this kind of cycle of craving that we all seem to be on, much of our lives.

Wendy Hasenkamp (00:25:04): Oh, that's so interesting. Yeah, you're kind of describing the experience that I'm sure we're all familiar with of—you really want something, you set a goal, it seems like that's going to be the be all and end all and make you happy. And then you get it, and it's great. And then after however long, it's like "Whatever, that's normal." And then there's the next thing, right? And so, that's the cycle that you're describing, of that continual craving?

Robin Nusslock (00:25:28): That's the cycle that I'm describing. And that's very much relevant for our understanding of the teachings of samsara, of the kind of cycle of, I get something and I savor it, and then I want more, and then I want more and so on. But it's also really relevant for understanding the terrible journey of addiction that people can fall into, because as people take certain addictive substances, it actually changes the reward circuits in ways that the brain needs more of that substance to get the same effect.

(00:25:59) And so, what will happen is that if once a person tries a particular addictive substance and takes that addictive substance, they may get a major kind of pleasure hit from the dopamine systems and the endogenous opioid systems, and the brain says, "Ah, I really want that." And then it does it again, and it says, "Oh, I really like that." And then it does it a number of times more. And what happens is that due to neuroplastic alterations in this particular brain system, the brain is saying, "I need more of the substance to get the same effect." So, there's this kind of habituation process, but there's also this amplification process, where we need more in order to feel the same thing.

(00:26:38) And this is something that has been really well established in preclinical and human research in people who suffer from substance abuse or substance misuse, is that eventually the rewiring of the brain happens in the sense that they don't even really enjoy the substance, but their brain is just so hijacked by the pursuit of the substance that they're kind of really stuck in this craving cycle that can generate so much pain and suffering in their lives.

Wendy Hasenkamp (00:27:05): We're off on a little bit of a tangent here, but just to follow it a little further, is there more to say from neuroscience about the next steps from the Buddhist perspective there? [There's] the roots of craving, and that's such a part of our suffering, but then within Buddhism, there's kind of the remedy. So, have you thought about, are there parallels there in what we're finding in neuroscience?

Robin Nusslock (00:27:30): Yeah. To me, the science of the brain's reward circuits and Buddhism are so synergistic in many ways. And I think what Buddhism offers, or contemplative traditions offer, is the ability to pause. And the ability to make the intention of stepping off the hedonic treadmill, which we all know is incredibly hard to do. I think there's a lot of evidence though, that if you practice the pause, you can strengthen the "muscle" in the brain that has the capacity to pause. And then the teachings will show us that we'll get back on the treadmill, and then we can get off again, and we get back on, and we get off again. And the teachers that I read and study say that it's really important to be gentle with ourselves when we get back on the treadmill, 500-600 times a day. *[laughter]*

(00:28:26) Because we have a brain that evolved to solve very ancient challenges, and challenges that were about our survival millions of years ago. And now we have the benefit and the curse of living with those brains in a current society. And so, it's really hard to practice that pause. But I think there's a lot of evidence that if you do practice that pause, you can actually generate positive neuroplastic changes in the brain that are across multiple areas of the brain—from memory systems, to prefrontal systems, to reward systems—in a way that really enhances and promotes positive mental and physical health.

(00:29:03) – *musical interlude* –

Wendy Hasenkamp (00:29:32): I was going to weave that idea back into what you were saying about stress and the effects on our various systems. Maybe you could say a little bit about how that sets us up for future health problems and struggles, and then maybe some of the remedies, or actions we can take to help.

Robin Nusslock (00:29:52): Yeah, so earlier I was talking about how the brain's stress systems, particularly centering around the amygdala and other brain regions, can activate this kind of cascade of stress physiology in the body that can increase heart rate, can increase respiration, and importantly actually increase inflammation. And so, this is a pathway through which stress in our environment can get underneath the skin, through the brain.

(00:30:21) Another pathway that we propose through which the mind can affect the body is via behavior. And so, if the brain, and the mind, and the body are in a state of stress or dysphoria or depression, or kind of low positive emotion, one of the things that we will do is we'll find ways of managing those difficult emotions. And one of the ways we manage them is through behaviors that are high risk and inflammatory—substance use, high fat foods, various other types of behaviors that can increase inflammation. And so, this suggests that another important pathway between the brain and the body through which stress can affect our well-being is through actual behavior.

(00:31:05) And there's a lot of research showing that people who have lower activation in these reward circuits in the brain are actually at heightened risk for engaging in substance use. We did a study some time ago where we brought people into the lab and we gave them a brain scan using MRI, functional MRI, and we examined the reward circuits in the brain. And we followed people for a number of years, and we found that people who had low reward-related brain function in this area called the ventral stratum were at increased risk of actually using substances and developing addictive behaviors in their lives. And so, this can all kind of enhance inflammation in the periphery.

(00:31:45) The final component of our neuroimmune model is that the communication between the brain and body is not a one-way street, it's a two-way street. And so, there's a lot of evidence suggesting that peripheral inflammation and organ systems in the body actually have a big effect on the brain. And this suggests that there's this bidirectional communication between the brain and the body that has implications for health.

(00:32:11) So, let me give you just a brief example of this. There are these proteins in the periphery called pro-inflammatory cytokines that we know, under certain conditions, can actually access the brain, and increase inflammation in the brain. There's also cells in the body called classical monocytes, which are really major drivers of inflammation. And what's becoming apparent is that these classical monocytes are actively recruited to the brain under conditions of stress. This makes sense because if the brain is in a state of defense, it wants the body to communicate, and if the body's in a state of defense, it wants the brain to be in a state of defense.

(00:32:46) So, these systems really synergistically work with each other. Super adaptive in the short term, right? This was meant to really facilitate a protective stance in the brain and body. But when this is chronic, particularly if a person's growing up under conditions of chronic stress, this can become dysregulated and again, set the soil for a number of mental and physical health problems across the lifespan.

Wendy Hasenkamp (00:33:08): I'm wondering too, you were just talking about inflammation in the body then having all these effects on the brain... So, I'm thinking about things like environmental toxins, and diet, and microbiome. It becomes so much larger of a picture. I assume that all plays into this as well, in terms of the inflammation?

Robin Nusslock (00:33:27): Absolutely, yeah. And I think that one of the things that I'm appreciating is the importance of realizing that medicine, for all of its incredible glory, has really carved organ systems into these isolated mechanics. And I think what we're realizing is that these systems really communicate with each other in ways that have important implications for health. We're really at an exciting inflection point in the study of human behavior and human health to recognize that organ systems are in direct communication in ways that have impacts for health.

(00:34:03) We're also, I think, recognizing that human biology is fundamentally social biology, that we can't remove human biology from the context with which the person grew up in and in which the person exists. We know that if people are living in poverty, they have a much earlier mortality than individuals who are not growing up in poverty. In fact, there was a study recently published in which individuals who are living in one community in Chicago, which is characterized by high poverty, have an average life expectancy that's 30 years less than if you're living in a high socioeconomic status environment. And the distance between those two zip codes is eight miles. So, it just highlights for us the absolutely primary effect that early life experiences, and social, and environmental experiences have on health and human development. And so, one of the questions that really defines my career is how is it that these health

disparities and health outcomes emerge? And maybe perhaps more importantly, what can we do about it?

Wendy Hasenkamp (00:35:09): Right, which brings up all sorts of structural issues, and policy issues and things like that. So, yeah, I want to touch back on that. Another thing that came up for me while you were just speaking of the experience of poverty, and the ways that these things are contextually determined is also, I'm wondering whether there's any epigenetic work in this field and thinking about intergenerational trauma. Is there anything known about how that weaves into these stress-responsive systems?

Robin Nusslock (00:35:39): Yeah, it's a great question. So, one of the things that is becoming apparent, as I alluded to, is the fact that biology is very dynamic. The more I study the biology of the human brain and body, the more I really begin to appreciate that it's molded and sculpted by experience, much more than I initially thought. And I really appreciate this insight because it challenges the deterministic, kind of static view that I think many people have of biology, which is that DNA is destiny and that there's these kind of traits built into our biology that really determined our life outcome.

(00:36:15) And I'm just not seeing a lot of that as the evidence plays out. I'm really seeing a biological system that's very affected by life experience, across the arc of development and throughout the arc of life. And this is a source of great optimism because I think the ideas of neuroplasticity, genomic plasticity, biological plasticity are real. But it also highlights, I think, maybe the moral imperative we have to really make sure that people are growing up in an environment that is characterized by equal opportunity to thrive and survive.

(00:36:48) One of the things that's becoming apparent is that stress absolutely affects the body and the brain through multiple mechanisms. One is through epigenetics. So, epigenetics is this fascinating concept in biology, which is the idea that we don't want to express every gene in every cell, because we need a brain cell to express proteins associated with the brain. We need a liver cell to express proteins associated with the liver. And so, the early epigenetic research was very much about understanding how is it that tissues are differentiated.

Wendy Hasenkamp (00:37:18): Because they all have the same DNA, right?

Robin Nusslock (00:37:20): They all have the same DNA. So, you have your entire genome—3 billion base pairs of nucleotide sequences or whatever it is—in every cell. (I mean, just that's a mind bender right there.) But then what's interesting is that every cell has to pack that entire DNA package into its chromosomes, into its cell, and only express very specific genes associated with that particular organ system that it finds itself in.

(00:37:45) But above and beyond that, what's become apparent is that amongst the genes that are being expressed in a particular cell, it's apparent that life experiences and stress really affect how much a gene is turned on or turned off. And so, this is really opening up this fascinating question of functional genomics—of moving away just from DNA as being the interesting process of genomics, to really understanding DNA needs to be expressed and life experiences, whether it's inside or outside the body, turn on the expression of those genes.

(00:38:14) And so, really foundational work has shown that if a mouse, a primate, or a human is growing up in an adverse situation, it has different profiles of epigenetic markers than those that are growing up

in a different environment, because it's expressing different genes associated with the stressors of that environment.

(00:38:33) I think a very interesting question that has been put forth is, well, maybe those markers are expressed intergenerationally. I honestly don't know if epigenetic processes are the mechanisms of intergenerational transmission of stress. There's a hot debate on that particular topic. But I think there's a wonderful set of writings and a large amount of data to suggest that there's numerous mechanisms through which intergenerational transmission of stress can occur—whether it's epigenetic, whether it's through prenatal environment, whether it's through dietary processes and et cetera—that absolutely elaborate pathways through which stress in one generation can get to the subsequent generation, and kind of feed a multi-generational cycle of stress.

Wendy Hasenkamp (00:39:17): Right, which then again, comes back to what you were saying before about systemic and structural issues in a society that can perpetuate more of those disadvantages that people might come into the world with.

Robin Nusslock (00:39:29): Yeah.

Wendy Hasenkamp (00:39:30): So yeah, that can bring us into thinking about, what can we do in terms of interventions around this, at these different levels—individually up to maybe societally. So, how are you thinking about that?

Robin Nusslock (00:39:43): That's in many respects the most important question, right? So, the ultimate goal of understanding how stress gets underneath the skin is to then guide therapeutic interventions or lifestyles that really enhance a person's well-being and capacity to flourish. One of the benefits of a multi-organ or holistic perspective of health is that it really provides multiple avenues into healing. It may suggest body interventions, it may suggest mental interventions, it may suggest familial interventions, and it may suggest structural or societal interventions. And in a way, it also highlights the value of a personalized perspective, depending on that person's experience.

(00:40:30) There's a lot of evidence by people who are the founders and the leaders of Mind & Life that contemplative practices can absolutely affect the brain and body. And numerous people affiliated with Mind & Life have really been the leaders of this field. So, showing that contemplative practices can affect the structure and function of the brain, that contemplative practices can affect the immune system, including gene expression pathways associated with inflammation. And so, I will defer the listeners to those podcasts and speakers about the specifics of that particular work, because it's numerous—and wonderfully summarized recently in Richie Davidson's and Daniel Goleman's book *Altered Traits*.

(00:41:19) But I'll give a few thoughts on other levels of analysis. So, some work that's very interesting is work on the family level of analysis. So, this is the work of Gene Brody at the University of Georgia who's shown really beautiful work that if a family is growing up in adversity, that if you can actually help the family maintain a nurturing, supportive environment, that can actually have substantial effects on the child's psychological, biological, and even genomic well-being. This work has shown that if families go through an eight-week or so intervention that's really designed and facilitating nurturing communication with children, that the children have benefits that are long-lasting, actually decades lasting. This includes effects of life outcome. This includes outcomes in cardiometabolic health, in inflammatory health, and even in profiles of gene expression that we talked about. So, suggesting that there are things that

families can really do to create a nurturing environment. And that sense of paternal and maternal warmth really affects the developing brain and body.

Wendy Hasenkamp (00:42:28): That sounding very related to ideas around attachment theory and developing secure attachment. Is that part of that literature?

Robin Nusslock (00:42:37): Yeah. I think it's all centered around the idea that if a child feels safe, however you want to phrase that—as secure attachment or as a quiescent amygdala *[laughter]* or whatever the wording is—if a child has a sense of safety in its environment, in itself, in its family, that it will develop in a way that has a stress physiological response that is less prone to be chronic. And it's really chronic stress that appears to be so problematic for the developing brain and body. So, I think it absolutely relates to attachment theory.

Wendy Hasenkamp (00:43:15): Yeah, great. Okay, sorry, you were talking about interventions.

Robin Nusslock (00:43:19): Yeah, no. And so, these interventions have also been shown to have intergenerational effects. So, I'm very fortunate to have a grant with Gene at the moment where we're doing brain scans and drawing blood to assess functional genomics and immunology on multiple generations of individuals as a part of his study—to really examine these questions of intergenerational transmission of stress, and how long-lasting are these effects, if you can optimize the familial milieu for a developing child.

(00:43:51) But one of the things that I think is important to compliment this work of maximizing resiliency among individuals who are growing up in adverse environments is to recognizing that, well, maybe we also have a moral imperative as a society to help minimize the exposure to adversity. And there's a wonderful quote by Muna Abdi who is a researcher who studies diversity, equity, and inclusion who says that, "Instead of praising people for being resilient, maybe we should change the structural inequities in society that require them to be resilient."

Wendy Hasenkamp (00:44:27): Yes.

Robin Nusslock (00:44:28): And so, one of the ways, and a very small way that I've been trying to examine this—I've been very influenced by these ideas and thoughts—is to actually say, "Well, could we examine the effect of a livable wage or a livable income on the developing brain and body?" And so, we have some grants under review at the moment in which we've piggybacked on the work of a philanthropist that's given 500 families $1,000 a month for multiple years, actually three years. And so, we're proposing to scan the brains and draw blood on the children of the parents getting this money to see if whether, if you really increase the financial stability of a family, does that have positive and salubrious effects on the developing brain and body of children?

(00:45:20) And so, I think the summary point for me on interventions is that we can approach healing at multiple different ways and multiple different levels of analysis—from contemplative practice, to psychotherapeutics, to family, to society. And I see all of these levels of analysis as really kind of symbiotically relating with each other, and working in collaboration as opposed to competition with each other.

(00:45:46) – *musical interlude* –

Wendy Hasenkamp (00:46:16): Another thing that I wanted to chat with you about, which I think is really fascinating, is you've become involved with a project working with Tibetan monastics, and teaching them science and engaging them with the process of science. And I love this on so many levels, both of course, the dialogue between Buddhism and science and really advancing that, but also your long interest also in Buddhism, and Tibetan Buddhism. So, I would love to hear a little bit about that program that you're working on and some of the goals, and how it's going.

Robin Nusslock (00:46:47): Yeah. So, as I mentioned, my love of the study of mind really began with the love of Buddhism and the contemplative traditions, going back to that first book that my mom bought me for as a holiday present. And so, about five, six years ago, I got an email from Carol Worthman who is at Emory University, who is an anthropologist there, saying that, "There's this amazing program called the Emory-Tibet Science Initiative, which involves having academics go to India to teach science to Tibetan Buddhist monastics in these monastic universities and Buddhist monasteries." And I remember being like, "Oh my gosh, this is a chance to come full circle, to come back to my Buddhist roots and my interest in contemplative traditions." And I was in the middle of a series of grants that particular year, and I was like, "Oh, I just don't think I could do it."

(00:47:45) And then I got an email from Carol the next year saying, "Can you do it this year?" And I was talking with my partner Park, and really attribute her to being like, "You should really go do this." And so, I'm grateful to her. And I said, "Okay. Let's go do this." And she came with me. And so, we went to India, and little did I know I was really going to have a life-changing experience, because I walked into a truly extraordinary program called the Emory-Tibet Science Initiative, which I know you've been a part of.

(00:48:21) And so, in brief for listeners, the Emory-Tibet Science Initiative really grew out of the spirit and the insight of His Holiness the Dalai Lama, who has had a lifelong interest in science, and I think from a kid was very interested in understanding how the world worked through both Buddhist practices, but also just a general curiosity. And he's had multiple conversations with scientists over the course of his life. Obviously, physicists like David Bohm, but in Mind & Life, it's very well known that Richie Davidson and Cliff Saron and Jon Kabat-Zinn and Francisco Varela and Joan Halifax and all these really luminaries of the study of mind, were going to have these rich conversations with His Holiness in the 1990s.

(00:49:05) And through these conversations, I think His Holiness really recognized that it was important to include the monastic community in these conversations. And so, he started to collaborate with just an extraordinary person, Geshe Lobsang Tenzin Negi, who was a monastic in the Tibetan Buddhist lineage in India, and then proceeded to become a professor at Emory University. And the two of them really together created the Emory-Tibet Science Initiative (ETSI), which initially involved the six-year educational program in which academic scientists and teachers would go over to India and teach classes on physics and neuroscience and biology and philosophy. And I know, I think you were part of the, maybe was it the first year?

Wendy Hasenkamp (00:49:48): I think it was the second year. I was involved in developing the pilot curriculum while I was at Emory, and then I went for two summers to teach. So yeah, it was amazing.

Robin Nusslock (00:49:59): And I love the stories of just the early years where it's like, "Well, you just hope everything works and the equipment works." Those were really early years in you, and I know Susan Bauer-Wu was there as well, were really the pioneers, and teaching this amazing set of courses.

And in 2019ish I think, they graduated their first group of people from the first six years of the program, and now we're in what's called the sustainability phase of the Emory-Tibet Science Initiative.

(00:50:26) And one of the goals of the sustainability phase is actually to move beyond just teaching monastic science, to actually engaging them in science, and really creating opportunities for Tibetan monastics to learn science through doing science. And I think there's really two goals to this program. The first is to create experiential learning opportunities. The second is to, I think really honor what His Holiness is called the 100-year journey, which is to actually begin true collaborations between academic scientists and Tibetan Buddhist monastics. So it's no longer two different groups of people just talking with each other. It's a movement from "us and them" to "we," where we're actually collaborating on questions of mind and questions of matter as a team.

(00:51:18) Buddhism really has an incredible investigation of a first-person model of studying the mind of experiential learning. And science has kind of more of a third person investigation of the mind—of quantification, and verification, and scientific method. And I think we all recognize that there may be something really beautiful in the combination of these particular approaches. And it's just a privilege to be a small part of this conversation.

Wendy Hasenkamp (00:51:43): Yeah. That's so wonderful. When I was there in the early years, I remember... Perhaps its worth saying, traditional Tibetan monastic education had not involved any scientific concepts whatsoever. It's more heavy on philosophy and texts and debate and logic and those kinds of things, which is very advanced at those levels, but really no science whatsoever. So, in the early days, yeah the goal was just to kind of give them a basic exposure to these concepts, and even how you think about science, and what we're learning from science in some different domains.

(00:52:16) And I remember thinking back then, "Okay well, we'll just give them these general concepts, and it's not like they need to *be* scientists, or they're going to be *doing* science." So, in my mind in those days, there was a limit kind of there. But to see how it's advanced in the last 10, 15 years, just amazing. And there's now actual science centers at the monasteries, and some of the monastics who went through the early program are now running those centers and really, really learning about science in the work that you're doing with them. So, it's so gratifying and amazing to see. Do you want to share a little bit about... I know you're doing a research project with some of them now about lucid dreaming?

Robin Nusslock (00:52:55): Yeah, so we're doing a few things. So, I've had the privilege of, along with a colleague of mine at Emory, Professor Nicole Gerardo, of kind of taking over the research training portion of the Emory-Tibet Science Initiative. And so, we're doing a few things to really facilitate this training and research. And I really, I love your story, which is just to see the evolution so rapidly from like, okay, we're not necessarily going to be in a scenario where monastics are doing science, to now in a scenario where they actually are doing science. And it's really, really exciting.

(00:53:29) And so, there's a few things that we're doing. The first thing that we're doing is we're running a two-week workshop in India every December now, which is where we do very basic introductions to scientific methods, scientific techniques—everything from how to create a spreadsheet to what a hypothesis is to basic scientific methodology.

(00:53:52) And then also recognizing during these classes that, in addition to the scientific method technology, that there's a shared curiosity [between] Buddhism and science—that science and Buddhism really are about an investigation of the fabric of reality. And so, highlighting the fact that

we're really collaborators here to the core. We're just using slightly different methods, but we're just both fundamentally curious about the fabric of reality and let's talk about it.

(00:54:21) Another thing that we're doing is, as part of that program, we have built neuroscience laboratories in the monasteries in India. And so, we have one neuroscience lab that's a sleep laboratory that I'll talk about in a moment, that's at the Drepung Loseling Center in India. And this has been built by the monastic community. I mean, it's just wonderful to see because we weren't able to be over there for six months. So, they've really been building it, which is incredible. And also, Marieke Van Vugt at Sera monasteries has built an amazing neuroscience laboratory there, and I'm having the privilege of collaborating with her.

(00:54:57) And then finally what we've done is last year, we ran our inaugural Northwestern University monastic neuroscience internship, where we identified five individuals who really wanted to go deeper in the training. And they actually came to my laboratory at Northwestern and trained in human brain imaging, trained in EEG, and really essentially became a part of my lab for a prolonged period of time, and trained in these techniques. And that has been one of the highlights of my career.

(00:55:23) So, what are some of the projects that we're doing? Well, I think one of the projects that's really exciting, that I think for me really reflects a project that is the confluence of the insights of science and Buddhism—that may not be able to exist without this true collaboration—involves Ken Paller at Northwestern University and also Marcia Grabowecky. And Ken is a sleep researcher who has done amazing research to be able to actually have realtime conversations with people while they're in a lucid dream state. So, he brings people into the laboratory, he puts an EEG cap on their head, and then they go to sleep. And you can really determine with great precision when a person is in REM sleep, rapid eye movement sleep, based on the kind of confluence of brain activity and peripheral physiology. And then Ken took it to the next level where he actually started to try to have conversations with people who are known lucid dreamers, in these particular REM sleep states.

Wendy Hasenkamp (00:56:16): Maybe it's worth just saying what lucid dreaming is in case listeners aren't familiar.

Robin Nusslock (00:56:20): Yes. I'm so sorry, yes. Lucid dreaming is this really fascinating state in which you are actually aware, when you're sleeping, that you're having a dream. So, a lucid dream is this state where you're in a dream, and you know you're in a dream, and you're consciously aware that you're in a dream. And it's a really interesting psychological state. I don't lucid dream that much, but people who do lucid dream tell me that it's quite interesting. Do you lucid dream?

Wendy Hasenkamp (00:56:51): I don't. Is it something that you can train, though? I hear that it's a trainable skill.

Robin Nusslock (00:56:56): It's absolutely something you can train. It's funny, I'm just somebody who's like, when I go to bed, sometimes I just want to be out. *[laughter]* But I'm sure I'll drink the Kool-Aid sooner than later and go through the lucid dreaming training. But I find it to be a fascinating insight into the nature of consciousness, because here we are, we're putatively asleep, but we're conscious, and we're aware that we're conscious of being asleep.

Wendy Hasenkamp (00:57:18): And then you can manipulate the dream, right?

Robin Nusslock (00:57:20): And you can manipulate the dream, yeah. I mean, I think there's dimensions of how lucid people are. Sometimes people just have a slight whisper that they're lucid. Other times people are like, "I'm going to fly now," and they start flying in their dream, or they have much more control. But Ken has done really remarkable work training people to become lucid dreamers, bringing them into the lab, and then you can actually communicate with somebody when they're in a lucid dream state. And the way you communicate with them is through their eye movements, because when you're in a REM sleep state, you're paralyzed, right? So, you don't want to act out your dreams because that would be dangerous. So, biology is wired itself that it basically paralyzes you when you're in one of these REM sleeps. But you can move your eyes, hence the name "rapid eye movement" sleep.

(00:58:04) So he can make contact with them through talking very softly, saying, "Are you there? Are you there?" And sometimes people will say, "Ah, I am here." And they'll communicate with their eyes. He'll say, "Move your eyes twice to the right to say yes, or three times to the left to say no." And now we've got this new frontier of consciousness where Ken is really having direct communication with people while they're in a lucid dream state. And it's just for me a beautiful insight into a frontier of consciousness.

(00:58:33) It turns out that in the Tibetan Buddhist tradition, there's these wonderful traditions of dream yoga, where people will actually do yogic practices while in a lucid dream state as part of their meditation training. And so, we're currently running a project where we built a sleep laboratory at Drepung Loseling Monastery in India, and the monastics who have been a part of my lab and Ken's lab at Northwestern have been trained in setting up all the EEG equipment. And they are now going out and finding dream yoga practitioners to participate, to come to the laboratory in India and try to actually do real-time lucid dreaming communication with them while they're in a lucid dream state. And then seeing if they can actually do meditation practice, on versus off, while lucid dreaming in a dream state, while recording brain activity, to see if we can just do a proof of concept of whether this is possible.

(00:59:30) Where this will go, I don't know. But I think it really is a rich confluence of Tibetan Buddhist knowledge and scientific knowledge coming together into a really creative collaboration that from my standpoint, is so exciting because it's being led by the monastic community, by monastic scientists, which is so exciting.

Wendy Hasenkamp (00:59:49): Oh, that's amazing. It's really exciting to hear about. I'm wondering if you want to, as we're wrapping up, just your reflections on maybe the larger potential of this collaboration between Buddhism and science, and what you've experienced or what you see might be possible.

Robin Nusslock (01:00:05): So, the first thing I'd like to do in answering that wonderful question is just recognize the pioneers of this work. It was so fun to be at Mind & life at the Summer Research Institute this summer and talk to Cliff Saron, who talked about the early days where he and Richie Davidson and Francisco Varela and others were hauling all of this equipment up into the Himalayas, and they really were pioneers. And so, it's just a privilege to be a part of the conversation at this point in time.

(01:00:35) So, where will this go? I think that there's a number of inroads to that question. First is the goal of really creating experiential learning opportunities for the monastics, because I think His Holiness really has highlighted how important it is for science training and science education to be a part of the monastic community. It's amazing to emphasize that this ETSI program—really initiated by Geshe Lobsang and Carol Worthman and Arri Eisen and all of these amazing people at Emory—is the first

change in the Tibetan Buddhist monastic curriculum in 600 years. So, this is really a historical thing that they did. And so really creating science opportunities and experiential learning opportunities.

(01:01:18) I think a second possibility is to really develop true collaborations between academic scientists and Tibetan Buddhist monastics. So, much of the research on meditation, rightfully so, is focused on academic scientists coming in and studying monastics. And I think we're at an exciting inflection point where the conversation can be very reciprocal, and that we can take these first- and third-person methods and really combine them into something that may be much greater than the sum of its parts. It's apparent to me in teaching these courses and training programs that it's going to take some time on the technical side, but it's also apparent to me how much richer and exciting it is than I could have imagined, on the intellectual and conceptual side. And so, who knows where it's going to go? I mean, next year at Mind & Life, the hope is that we'll have Tibetan monastics actually presenting posters now on their own research projects. So that's... I think publications, and who knows where we're going next.

(01:02:17) The final point I'd like to mention though is that, this is much more than scientists coming in and teaching monastics. This is a cross-cultural conversation that I think is very rich and it's really moving from "us and them" to a "we" of collaboration. And I would say as a scientist, that we as the scientific community need this conversation and collaboration as much, if not more so than the Tibetan Buddhist community. We're at a point in time where we have remarkably powerful capabilities as scientists. We can edit the genomes of living tissue using CRISPR technology. We have the birth of AI. We have the ability to modulate the structure and function of the brain in real time. I think we as scientists really need an ethical framework to guide us into the next 200 years of where we're going. And I don't see there being a better ethical framework than the north star of compassion, and the contemplative ethics put forth by the Tibetan Buddhist community—of just always leading with compassion, and [asking] is this for the greater good?

(01:03:21) So it's important for me to highlight that this conversation between academic scientists and Tibetan monastics is really a cross-cultural conversation. And I feel like I'm much more the student than the teacher, and I'm learning so much from them. But I think we as a field as science really need to be guided by the ethical framework of compassion, and we have so much to learn from them. And so, it's just a privilege to be a part of the conversation.

Wendy Hasenkamp (01:03:46): Well, Robin, this has really been so wonderful to chat. And I so appreciate all of the important work that you're doing, and thank you for sharing with us today, and I look forward to keeping in touch and hearing more about how all this unfolds.

Robin Nusslock (01:04:00): Thank you so much. I remember, I think my first Mind & Life dialogue that I went to was in 2003, and to be able to come back full circle and be on the show with you has meant a lot to me. So, thank you so much.

Outro – Wendy Hasenkamp (01:04:16): *This episode was edited and produced by me and Phil Walker. And music on the show is from Blue Dot Sessions and Universal. Show notes and resources for this and other episodes can be found at podcast.mindandlife.org. If you enjoyed this episode, please rate and review us on Apple Podcasts, and share it with a friend. And if something in this conversation sparked insight for you, let us know. You can send an email or voice memo to podcast@mindandlife.org.*

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