Mind & Life Podcast Transcript
Emeran Mayer – Biological Interconnectedness

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Opening Quote – Emeran Mayer (00:04): *When we talk about the microbiome, you have to talk about the food, the nutrition. You have to talk [about] where this food comes from, how it's grown, the microbes in the soil. There's a planetary interconnectedness, so it's sort of expanded into a whole universe. The concept of interconnectedness, which obviously is at the center of contemplative practices and Buddhism, once you look at the world with different classes, it really explains a lot of the things that we have not taken into account, how we interact with the world. We want to make it a positive thing, and I think we're in the midst of this revolution, this paradigm shift. That's my sense of optimism.*

Intro – Wendy Hasenkamp (00:45): Welcome to Mind & Life. I'm Wendy Hasenkamp. Today, we're looking at interconnection through a biological lens, and it's one that I've been increasingly interested in over the last several years. My guest is Emeran Mayer, a gastroenterologist who's become a renowned expert on our microbiome—the countless number of microorganisms that live on and in our bodies. He's also an author, a meditator, a researcher, and a professor at UCLA's medical school.

(01:18) We've learned so much in the last few decades about the crucial role our microbiome plays in physical and emotional health, and its intricate links to our neurological and immune systems. Emeran provides a wonderful overview of all of this, and there's some pretty vast implications here about not only things like diet and stress, but also our relationship with nature, our standard agricultural and medical practices, social justice and food equity, and even the way we conceive of ourselves. Emeran and I take a deep dive into all of these topics. And if you're interested to learn more, definitely check out the show notes for this one. There's a lot more resources there.

(02:02) I've been just fascinated to follow what we're learning about the incredibly complex interactions between all the systems of our body, including our microbiome. And the more I learn, the more I feel like I'm getting a glimpse of the true nature and scale of the interconnectedness that we exist in. I hope this episode sheds some light on that for you too. It's a pleasure to share with you, Emeran Mayer.

Wendy Hasenkamp (02:29): Well, I'm so pleased to be joined today by Emeran Meyer. Emeran, thanks so much for being here. Welcome.

Emeran Mayer (02:35): Yeah, Wendy, thanks for having me on the show. It's a real pleasure.

Wendy Hasenkamp (02:39): Well, I'm really excited to dive into your work. You are an expert on our microbiome and our gut, which we will totally get into and is a really fascinating area—and something

we haven't discussed very much on the show, but I think there's implications much larger than that as well, which I'm sure we'll get into. So, first, I like to start with a little bit of background from the guests. So, I'm just curious for you personally, what led you to your studies in this area? I know you've had a long interest in the mind-body connection. Did that come first, or did the microbiome come first?

Emeran Mayer (03:12): No, the interest in the mind-body connection came way before. It was actually... that was my motivation to go to medical school. And I thought I was going to end up in psychiatry, but then the clinical experience of what psychiatry was like at that time in the 70s was not what I had in mind.

(03:32) So, with a lot of side stories, I ended up in gastroenterology, which is an area where the majority of patients have symptoms that involve both the mind and the gut. That became very clear to me early on. And then, I've pursued this, really in the beginning with a focus on irritable bowel syndrome. This was at the time the disease that lent itself most to these mind-brain-gut interactions. And then it's expanded, mainly through the microbiome. It has expanded to a whole range of diseases and disorders that today are called brain-gut disorders. So, that's really a relatively new thing, I would say, the last 10 years.

(04:11) And now, my interest ranges way beyond the initial interest in mind-body. It includes... if you talk about the microbiome, you have to talk about the food, the nutrition. You have to talk [about] where this food comes from, how it's grown, the microbes in the soil, planetary interconnectedness. So, it's sort of expanded into a whole universe, really, which suits me really well because that's what I was interested in when I was in college.

Wendy Hasenkamp (04:41): Oh, I love it. That's great. And you also have, at least personally, an interest in contemplative practices and that side of things too. Was that also alongside?

Emeran Mayer (04:51): Yeah, this has also been an interest of mine from the very beginning. When I came to the US in the late 70s for my specialty training in gastroenterology, I spent most of my weekends going to retreats, from Essalen to the Ojai Foundation in the Bay Area. And I was probably the only gastroenterology trainee who had that interest. *[laughter]* And I met a lot of very interesting people, joined a Zen Center in downtown LA.

(05:21) And then, I have to admit, I mean, during the peaks of my career with constant traveling, spending more time in the air than on the ground, the contemplative techniques and practices really took a backstage for a while. But it's really come back, I would say, the last 10 years or so with... there have been dimensions both from this mind-gut connection to psychedelics, which became an area of interest of mine as well. And I still would love to see the studies of how psychedelics influence the gut microbes.

Wendy Hasenkamp (05:59): Oh, my goodness. Yeah.

Emeran Mayer (06:00): This is definitely a component that right now nobody thinks about, but the same receptors, the serotonin receptors that psychedelics act on in the brain are in the gut, and actually are on the microbes as well. So, this will definitely be, in the future, a component. I won't be the person that's going to scientifically study that, but I would bet everything on it, that this will become another dimension.

Wendy Hasenkamp (06:26): Yeah, that's fascinating. Okay, well there's so much to dive into here, and I know we won't be able to cover all of your interests and experience in this short time, but let's begin maybe with the microbiome. Can you give just a short explainer for listeners who might not be too familiar with what that is, and what it does for us and with us?

Emeran Mayer (06:47): So, the term microbiome really combines both the microbiota, which are the players—who is there in the world of microbial organisms—and what these microbes produce, what functions that they have. So, microbiome is really both the structure, the architecture, but also the hundreds of millions of genes that they produce.

(07:09) So, microbes are everywhere. They're the oldest life form on the planet. They've lived in the oceans of planet Earth for billions of years. They've had enough time to perfect a communication system between each other, and there's tens of thousands of different microbes, and they all have learned to speak the same language. And when the first marine animals appeared, some microbes decided to live inside of these marine animals. And then this symbiosis developed between the gut of that primitive marine animal and the microbes. And that has essentially stayed for millions of years. Every animal has a microbiome.

(07:53) In humans, it means the microbiome is everywhere—on our body, on all our surfaces. But what's unique about the gut is it's where the highest density and concentration and amount of these microbes live. Microbes live from the mouth actually to the esophagus, to the stomach (very few in the stomach because of the acid that is really not a good environment). And then, increasing amounts down the intestine, the highest amounts in the large intestine. And it's estimated there's about 40 trillion of these microbes living in our intestines.

(08:33) I would say we're just scratching the surface [about] what these microbes do, where they live, how they function. Because we have relied mainly on stool samples to analyze who is there, and that's a mixture of everything from the mouth all the way down to the gut. What the science now is interested in is, what substances do these microbes produce, what functions do they have, how do they interact producing these chemicals?

(08:58) And when I say chemicals, [I mean] the chemicals that are signaling molecules, they're part of the microbes' language that they developed and stored in their hundreds of millions of genes. So, they were the first ones to speak that language. Our nervous system learned that language from them—first in the gut and then in the brain. And now when you think about it, all the higher levels of our brain functions go back to these microbes billions of years ago, how they came up with a language.

(09:33) So, yeah, I would say in the universe, our large intestine exhibits the highest density of these microorganisms. And there are bacteria, fungi, and viruses. It's not just the bacteria. We know most about the bacteria, we know much less about the viruses, and much less about the fungi.

(09:57) An important thing is everything inside, in our gut, it's a pretty unusual environment. There's no light. There's no oxygen. And so, it's all invisible, and it's probably one of the most complex ecosystems where the microbes, the fungi, the viruses interact with each other in a symbiotic way. And that symbiosis, or this intactness of this ecosystem, is really what makes up the health of our microbiome, in the simplest terms.

Wendy Hasenkamp (10:31): Oh, that's amazing. I love what you said about how we learned the system of communication in our gut and then in our brain from these microorganisms who've been doing it for

much longer than we have. That's really fascinating to think about. So, that really speaks to the interconnections between the gut and our brains. You were just starting to speak to that, and that's one of the areas that you've really studied deeply. So, can you share a little bit more about that, how that's connected?

Emeran Mayer (11:00): Yeah, and this is actually, understanding this shared language concept is essential for explaining why these microbes, in the darkness inside of us, would have anything to say to the brain that the brain would be interested in. And vice versa, because this communication goes in both directions.

(11:19) I mean, the microbes pretty much know every emotion that we're in—if we're angry, if we're anxious, if we're stressed. The microbes get the message from the brain, and they have receptors on their surface. So, if you release a stress hormone, the microbes will know that, and they will change their gene expression, and they'll change how they interact with us. So, it's a bidirectional communication, really.

Wendy Hasenkamp (11:42): Does the same thing go in the other direction? If we're eating something, maybe we have an intolerance or something like that, is that sending "threat signals" or "stress signals" to our brains?

Emeran Mayer (11:55): Absolutely. So, this is how this field initially exploded onto the scene, and that's what people were most fascinated by. Because we've known for a long time [about] the top-down communication. But this bottom-up, or how microbial signals can reach the brain... In simplistic terms, there's really three ways that they can do this, so three communication channels.

(12:18) One is the microbes produce so-called neuroactive substances. So, these are molecules that they generate from breakdown of our diet. Complex carbohydrates are broken down, for example, into these short-chain fatty acids, which have received a lot of attention because they have these anti-inflammatory effects on the gut, on the gut's nervous system, and on the brain.

(12:44) But there's also many chemicals, many neurotransmitter-like molecules—very similar to neurotransmitters in our brain—that these microbes generate from the food we eat. So, for example, tryptophan, when the microbes chew it up, results in several so-called metabolites or breakdown products, which are very similar in structure to our neurotransmitters. And they interact with our receptors for these transmitters. So, that's one communication channel.

(13:14) Another one is the vagus nerve. So, the vagus nerve is this vast nerve that essentially innovates all of our organs and sends signals to the brain. Eighty percent, ninety percent of the traffic in that vagus nerve goes from the gut to the brain. We never knew why that is the case, why there is such a discrepancy in the numbers. And now we know because the receptors for these microbial molecules are all on these vagal sensory terminals. So, whatever the microbes talk about will be transmitted to the brain via the vagus nerve. But also through the bloodstream, because these molecules get into the bloodstream. So a parallel communication system.

(14:03) And then, there's a third one, that the membrane of many microbes—the so-called gram-negative microbes—either the intact membrane or breakdown products interact with so-called toll-like receptors (that's T-O-L-L receptors) that respond to membrane components, and then generate inflammatory signals that go to the brain as well.

(14:27) So, we have neuroactive signals that go through the circulation. We have neuroactive signals that go through the vagus nerve, and we have these inflammatory molecules that go through the circulation, through the bloodstream, to the brain and affect immune cells within the brain as well. So, it's very complicated. And all three communication modes really interact with each other; it's this system where these three channels constantly talk to each other. So, you can imagine, if you try to figure this out—what microbe does what with which signaling molecule or communication channel—it's very challenging.

Wendy Hasenkamp (15:05): Yeah, it's starting to sound a lot like the complexity of the brain itself, right?

Emeran Mayer (15:09): It is. It is.

Wendy Hasenkamp (15:12): And there's also a whole nervous system in the gut too, right? You hear this concept of the "second brain."

Emeran Mayer (15:18): Yeah, the second brain concept has become popularized by a book that came out some 15 years ago by a very prominent neuroscientist, Michael Gershon. And it was very popular, that term. But in some ways, it's actually a misnomer, because it was really the first brain, as I mentioned.

Wendy Hasenkamp (15:37): Oh, right!

Emeran Mayer (15:38): So, the microbes settled the GI tracts of these primitive marine animals and helped these marine animals to develop their nervous system, which is a gut-based nervous system. And only later, when these animals developed heads and a polar structure, the same principles were then transported to the brain. So, the enteric nervous system is really our first brain, and then our current brains are second brain.

Wendy Hasenkamp (16:04): Ha, I love that.

(16:05) – *musical interlude* –

Wendy Hasenkamp (16:33) So, I'm curious to hear a little more about the ways that our gut and gut microbiome can affect our minds and our emotions, and things like that. I know there's been some interesting studies about fecal transplants changing people's mood or personality. Can you share a little bit about that work?

Emeran Mayer (16:52) Yeah. So, a lot of this science has really come from animal studies, where this is relatively easy to do. Because you can do these fecal transplants and you have laboratory mice that have no microbiome, and then you can add a human microbiome, or we can add a microbiome from a mouse with a different genetic background, with a different emotional behavior. So, 90% of that research has come from these mouse experiments.

(17:17) And it's been very challenging to actually reproduce this, or translate these animal findings, into human findings. Now, in English language and other languages as well, we always talk about our "gut feelings." But to actually pin this down into the same kind of science that we know from the animals—that we can generate anxiety-prone animal from a calm animal just by doing a fecal microbial transplant—that has not happened in humans, unfortunately. So, we can't say that. Nevertheless, from what I told you earlier, these communication channels, that influence has to be there. It's just, to study

it in humans with the limitations of what you can do experimentally in a human being, has been very challenging.

(18:08) But then, there are general things, the well-being that you feel, the sense of well-being and satiation after a meal, for example. So, that we understand fairly well. That involves the microbes to a certain degree as well, because these satiety hormones in our gut are released in part in response to stimuli from the microbes in our gut. So, that's an example where I could say there's good scientific evidence. There's also evidence from the other extreme. You know, the most miserable feeling that anybody could have or does remember is from a gastroenteritis. That affects you tremendously in your thinking, your cognitive abilities, and your emotions. And again, that's something where the microbes obviously play a major role in it.

(18:55) But the more subtle emotions in between—the anxiety or the depression—much harder to demonstrate, even though there's now a whole field of psychiatry, nutritional psychiatry, that has been publishing. But if you look at the more carefully written reviews on this, the investigators always emphasize, "We have limited evidence in humans to actually prove that." So, I would say, it's almost that there has to be a strong influence. But to tease it out from this complex system is a big challenge.

Wendy Hasenkamp (19:30): Yes, I could see that. I think whenever we approach such complex systems with a reductionist scientific lens, we run into a lot of challenges. We've seen that in the meditation literature as well sometimes, so yeah.

Emeran Mayer (19:44): Yeah. Since you mentioned the meditation literature... And we talked earlier about this top-down influence. I mean, there are a few studies, very limited, that a contemplative state has an effect on the microbes and on their functions. That's almost certainly happening.

Wendy Hasenkamp (20:04): Yes. I was going to ask you about that.

Emeran Mayer (20:05): I mean, I would bet all my money on it, that there's a strong influence. And it would be great with experienced meditators to look at this—not just what microbes are there, but actually what metabolites do they produce.

(20:18) And I should emphasize again, the field has moved rapidly from the early studies, where people always looked at DNA sequencing techniques to study which microbes are there. It's the same kind of tests that you can do now commercially. It doesn't tell you really much about what these microbes do; it just tells you who's there. But the science has moved rapidly to a field, which is called metabolomics or shotgun transcriptomics, where you want to know what genes are expressed by this community of microbes, and what molecules are produced by these microbes, in combination. It's not a single microbe.

(20:55) And yeah, I would bet all my money on it. That if you did a well-designed study today, where you look at this transcriptome, which genes are being expressed, that a contemplative state would change that, for sure. And then, from what we know, what happens with these metabolites, that they feed back to the brain. So, when we do a meditative state, it always involves the whole loop—from the brain to the gut, and then from the gut and the microbes back to the brain. It engages the whole system.

Wendy Hasenkamp (21:29): Yeah, that'll be really fascinating. Hopefully, that area of work will take off. I'm also thinking about... your latest book is also about the immune connection to all of this, which we

know has a lot of connections to our mind states and our brain, and also our gut. So, do you want to say anything about how that weave into this complex picture?

Emeran Mayer (21:49): Yeah, so that goes back to the complexity of the gut. I like to call it the gut connectome. So, we all talk about the brain connectome, how the nuclei in the brain are connected. In the gut, it's even more complicated because we have different systems. We have the immune system. We have the hormonal system, because the gut produces a lot of hormones. We have the enteric nervous system, and we have the microbiome. All these systems interact with each other and particularly within a very close spatial distance.

(22:23) So, the microbes are separated from our immune system... And I should say, 70% of our immune cells are located in the gut. So, the microbes are just microns away from these immune cells, and their sensors only separated by a tight layer of cells, the so-called epithelium, and by a layer of mucus, which makes up the gut barrier. And that separates these immune cells—that, if activated, could kill you—from 40 trillion microbes. So, you can imagine the complexity of that engineering feat that evolution has accomplished.

(23:02) So normally, the microbes do not come in touch with the immune system, despite the closeness, provided the mucus layer is intact, and provided that the epithelial layer doesn't have gaps in it or increased permeability. And there's many situations today where this is compromised, that barrier is compromised. So, certain immune cells, the so-called dendritic cells, they send out these sensors, these tentacles, into the mucus layer. And if the mucus layer is thinned by your diet or by chronic stress, then that allows microbes to come in contact with these sensors or the dendritic cells. And then the dendritic cells trigger the whole immune system cascade, which initially could be limited to the gut. But many times, it goes beyond the gut. And then, there is a loosening of these tight junctions between the epithelial cells, this whole phenomenon that's been called the "leaky gut." And then, all of a sudden, fragments of microbes or intact microbes can go into the immune system of the gut, and even into the systemic circulation reaching the brain, for example.

(24:21) So this is really at the crux of most of our current chronic disease epidemics—from colon cancer to neurodegenerative disorders like Alzheimer's or Parkinson's to cardiovascular disease. That compromised interface between the microbes and immune system is at the core of all these disorders. Which, when you think about it—what is the main influence on this barrier?

(24:50) It's really two things. One is the diet and the other one is the influences from the brain. And they have a similar effect. So, chronic stress or allostatic load, it compromises that barrier. So, you get an activation of the immune system. But our unhealthy diet, like the standard American diet with high fat, high sugar, and not enough fiber, all the contaminants, the chemicals in it, they do the same thing. So, if you put the two together, the bad diet and the chronic, the allostatic load, which can come from (as I'm sure many people have talked about this in your show), things like social isolation, loneliness, chronic stress. There's a range of negative emotions. All of them have, in some ways, a similar effect on this, how the brain talks to the gut and facilitates this chronic inflammation. You could almost say the crux of our current disease epidemic lies in the gut, and it lies in this compromised interaction between the microbes and the immune system.

Wendy Hasenkamp (26:04): Wow. So, is it that... What you were just saying about the leaky gut and how, when that barrier is compromised and parts of whatever is in your gut, including the microbes, can leak out, and that's what triggers this inflammation. And then it can go beyond just inflammation there at the gut. Is that what you mean? It can go systemic, and cause all these other kinds of problems?

Emeran Mayer (26:27): Yeah, and there's different stages of these compromised barriers. So, one is, you don't have to have holes in the gut lining for entire bacteria or food components to get into the systemic circulation. If these sensors on these dendritic cells I mentioned, in an otherwise intact gut, sense that there's microbes too close to them, that already rings the alarm bells and can trigger an inflammation that's limited to the gut.

(26:56) So I always say to audiences, particularly if you see that 40% are obese, that about 40% of you guys have metabolic syndrome, most likely. Which is a condition that indicates that arises from a compromised barrier in the gut, and leads to type 2 diabetes and hypertension...

(27:20) So it's almost like, hypertension—you don't sense it early on. It's something that goes on silently inside of your gut. You can see it if people look unhealthy, meaning mainly, the best indicator is always obesity, or if you see that people are chronically depressed. But we know what happens, actually. And it's a very scary thing. Because if you start out with this at a young age—and that seems to be the case because many diseases, many chronic diseases, are starting earlier and earlier, from colon cancer to inflammatory bowel disease, to type 2 diabetes. It's a phenomenon that's happened over the last 20 years; it's always a young age group. So, an individual who has that at age 15, that will affect longevity, or health span or lifespan in that individual. They may not know it until it's too late.

(28:18) – *musical interlude* –

Wendy Hasenkamp (28:44): So, what you were just saying about the compromised barriers and all of this immune-based chronic disease that we're suffering, what can we do to protect our guts and our bodies? Are there tips or changes that we can make?

Emeran Mayer (29:01): Yeah, this is definitely a challenge because of the multiple factors that contribute. So, I told you from the brain alone—social isolation, depression, chronic stress, basically a negative state of mind, food-related fears—I mean, there's so many factors that come in from the brain side and go down.

(29:24) First of all, you have to identify who is affected by which of these factors, and you have to deal with those. I usually get a good idea from talking to my patients, even within the hour of the consultation, where the main areas or where the main points of potential interventions are. That could range from cognitive behavioral therapy, to mindfulness-based stress reduction, to sometimes brain-targeted like antidepressants or anxiolytics. So that's one area.

(29:56) The other one clearly is food. And that's in some ways relatively easy from the concept because we know, if you want to do something good for your body, just do what's best for the microbes. And that means, the microbes love complex carbohydrates, which basically are fiber molecules, because they break them down into these molecules that are not only food for them, but also have these health benefits for us, like the short-chain fatty acids. So conceptually, that's very easy; just stick with a healthy diet. But practically, it's multiple barriers that people have.

Wendy Hasenkamp (30:37): And what is a healthy diet too, right? I guess that's a complex question.

Emeran Mayer (30:42): Normally, a healthy diet is essentially the Mediterranean type, traditional Mediterranean type diet. It's not a contemporary Italian diet, which is not that healthy anymore, because of all the meat and lots of pasta. But the Mediterranean diet, essentially 75% of your food

coming from plant-based sources, which will provide your microbes with the right molecules to be healthy. It's a diverse diet. So, if you were a vegan and you would just eat one type of vegetable for the whole month, it would actually be pretty bad for your microbes. The more different types of fruits and vegetables and seeds you eat, the more different types of microbes you need to break that food down. So you get diversity, which is really the goal here. You want the most diverse system.

(31:35) And then it gets into a whole science. Then you should look at, where does this food come from? Is it organically grown? Is it grown according to the principles of sustainable organic agriculture? Which means no chemical fertilizers, it's all organic fertilizers. So, it gets very complicated. And then, I always ask myself—this may be okay for people in San Francisco and West LA and New York maybe, but what about all the rest of the US population? They don't have the time to think about it. They don't have the money, and they don't have access to these kinds of foods. So, it's a pretty grim situation. We know all the science, but it's very difficult to get it to the consumers.

(32:22) But if you follow this path of doing everything that's good for your brain, for your nervous system, and everything is good for your gut, for your gut microbes, you're already doing a lot. Then, there's other things. There's sleep. We know that poor sleep affects the gut microbes as well and contributes to the low-grade inflammatory state. We know that extreme exercise has the same negative effect. So, while moderate daily exercise is highly recommended and has been shown to be beneficial to the diversity, extreme exercise—and that's triathlon or ultra-marathons—actually have the opposite effect. They create inflammation in the gut, just like the unhealthy food does.

Wendy Hasenkamp (33:05): Because it's a kind of stress to the system?

Emeran Mayer (33:07): Yeah, it's a stress. So, you could almost say any form of chronic stress— be it dietary, be it lifestyle-wise, be it stressing your brain by lack of sleep—it all converges onto the same end result, increasing your inflammatory state. And because 70% of the immune system is in the gut, it usually starts in the gut. It's the central hub. I never thought when I chose gastroenterology that the gut would come out as the main hub in our system, but it seems that it's really the case. *[laughter]*

Wendy Hasenkamp (33:51): It's so interesting... When you were describing it earlier, I don't know why I've never thought about it this way, but it sounds almost like the gut is like another sense organ, right? It's tuned up to sense our entire external environment, or whatever's coming into us. Does that make any sense from your perspective?

Emeran Mayer (34:07): No, absolutely. When I started to get interested in irritable bowel syndrome (IBS), the sensory part of the gut became my main interest. And we showed in many studies that the increased perception or sensitivity of the gut is the key to explain the symptoms that patients with IBS have.

(34:28) But that can be expanded because all the mechanisms that... This 70% of the vagus nerve, that goes from the gut to the brain—and the vagus nerve is one of the most complex sensory systems in our body. But then, you have the hormonal signals. Everything that's being sensed in the gut that comes from outside, but also from the top, you could say, yeah, it is the most complex sensory organ in the body.

Wendy Hasenkamp (34:54): Yes, that's fascinating. And you were also talking about diversity, and the importance of diversity in our microbiome. I've also heard that there's a lot of... Just ecologically, are we losing diversity in terms of the microbes that are even out there now?

Emeran Mayer (35:11): Yeah. So, there's a film out now, *The Invisible Extinction*, by husband-and-wife scientists, Martin Blaser and Gloria Dominguez. Great film that has shown this—and they've studied this, how many microbes have already disappeared. And they can do this by comparing the remnants of ancient hunter-gatherer groups in the world, like on the Orinoco River, in the Amazon rainforest, and in East Africa, the Hadza people. They've shown this... they've actually started a project collecting microbes. It's like a microbe vault, where they want to collect microbes before they go extinct.

(35:53) And this is happening both inside of our bodies, but also obviously outside. We're in this latest mass extinction phase of the planet. But this happens both outside and inside of us. So, the consequences of this are, if we don't find a way to bring those microbes back, we will have permanently lost one of the main hallmarks of a healthy microbiome—the diversity and the richness. So, it's not just how many different microbes are there, which is the diversity, but how many of each of those species are there. That's the richness. And both of those have been going down.

Wendy Hasenkamp (36:33): Is that also due to environmental contamination and things from human activity? Do they know why?

Emeran Mayer (36:40): The major factor in humans in the gut is the antibiotics. Antibiotics are this miracle drug that has been invented as saved hundreds of millions of lives. But at the same time, the irresponsible use of antibiotics for viral infections and not identified bacterial infections has led to... And it's particularly harmful early in life. So, a lot of kids by the age of five have already had 10 courses of antibiotics. And that's the time where the microbial ecosystem is being established—early in life, the first three years, three, four years of life.

(37:18) And it even starts during pregnancy. So, a pregnant mother treated with antibiotics will have a compromised microbial ecosystem that has an influence on the developing fetus. Because the fetal microbiome ecosystem is initially influenced largely by the mother, in utero, but then also during delivery coming in contact with the vaginal microbiome. So, we use antibiotics in the delivery room for prophylaxis of staph infections. So, we bombard the system from very early on. Some people say, even preconception, it would start there.

(38:04) And we've not really changed that significantly. The delivery practices have not really changed dramatically with that science. Martin Blaser's book, the *Missing Microbe*, if you read this, it's kind of a grim scenario. If we continue... not just the development of antibiotic resistance—that a lot of microbes now are no longer sensitive to our existing antibiotics—but also this decrease in diversity.

(38:33) And it's something that, sadly... I just came back from this trip to Brazil, and we spent a few days in the rainforest, the Pantanal. So, this is an area with the highest diverse biodiversity in the world. And you can see in that area within half an hour, you go from this amazing rainforest with this abundance of birds and fish and big mammals, and you drive out there, and then you see these vast areas where the forest has been cut down. And it's all monoculture of soybeans and corn. And not only is it that... these monocultures, they are GMO-supported agriculture, so they spray them with pesticides, insecticides. It's really painful to go through this transition.

(39:27) We almost had this high, staying a few days in this lodge in the jungle and seeing macaws and monkeys and tapir. It was just amazing. And then you drive out and you see this destruction of the ecosystem. And it really came back to me, this is what we're doing—not to that extreme degree, but in many ways—that's what we're doing to our internal diversity as well.

(39:55) But there is hope. So, for example, in this area in Brazil, there's all these NGOs that are aimed at bringing back some of these animals that are threatened by extinction. So, there's the Blue Macaw Foundation, there's the Jaguar Foundation. And they've all been successful, they've been highly successful. So this is something I think we should learn from these people, that it is possible to bring these animals back.

(40:24) And we have... I mean, there are ideas that Dr. Blaser always talks about. We could bring those back if we introduce microbes that have gone extinct that they store in this vault early on in life, when the ecosystem still allows us to introduce new organisms. So, one could see a world where babies, newborns, get a fecal microbial transplant or pills that contain consortia, these microbes, early on in life, and then they would have those.

(40:59) So it's definitely... there are ways to counteract it. I'm not sure if humans are really able and willing to change their behavior on the planet anytime soon enough to prevent some really major negative things to happen.

Wendy Hasenkamp (41:16): Yeah, yeah. You were talking about the way that our microbiome is set up so early in life, and even impacts from the pregnant mother, and if she is exposed to antibiotics, for example, that can impact the developing fetus. I'm wondering, based on what you were saying earlier about stress and things like that, has there been any research on the mother and conditions in her life, and if there's stress there, does that impact the development from a microbiota perspective of the fetus?

Emeran Mayer (41:48): Yeah, absolutely. So, there's some very elegant animal experiments that have shown that a relatively mild stress, auditory stress of pregnant rat mothers or mouse mothers, that they affect the composition of the vaginal microbiome. And the vaginal microbiome is really, during delivery, it's a mixture of the gut microbiome and the vaginal, there's both.

(42:11) But that the stress of the pregnant mother would change these microbes, so the infant gets its first inoculus of a compromised microbiome from the mother. And they've shown in this mouse offspring that they had neurological or brain changes in the developing nervous system. So, it's quite possible that chronic disease of the mother, which could be an infection, there's many studies that suggest this plays a role in autism spectrum. So, if the mother underwent a viral infection during pregnancy, that affects the offspring.

(42:47) It's also been shown that metabolic syndrome, type 2 diabetes, obesity, in the pregnant mother affects the risk of a baby having autism spectrum. It's never that that's the only explanation. You need the vulnerability genes. You need other factors. But I mean, I wish there were more education of mothers, what important role the health of the microbiome plays in the healthy development of their babies.

Wendy Hasenkamp (43:15): Yeah. And it's also so complicated, as you were saying before, because it's not always up to us to determine the stresses around us, or the ways that we are exposed to environmental toxins or other kinds of things like that. So, there's also systemic factors at play.

Emeran Mayer (43:32): Yeah.

(43:32) – *musical interlude* –

Wendy Hasenkamp (44:02): I would love to bring in your interest in the contemplative space. Thinking more broadly, you've spoken a lot already to the interconnectedness at all of these levels, from the bacteria and microbes that live inside us all the way up to planetary health and environmental destruction, and things like that. I'm wondering other insights or other links that you may draw. One that comes to my mind is thinking about our concept of self. And we have all of these organisms living inside of us... it's yet another way of shaking up our idea that we have some solid self. So, I'd just love any reflections on that, or anything else from the contemplative side that you've brought into this.

Emeran Mayer (44:45): Yeah, I would definitely say that... I mean, it goes into all these definitions. What is the mind, and what is the self? Is the self an artifact that our brain creates to be able to deal most effectively with the world around us? So, certainly, thinking about these dimensions, and the history, when we think about billions of years of development of these gigantic microbial communities that have more microbes than stars in galaxies. So, the number game is phenomenal.

(45:22) So, to think that the sense of self is something more than a useful artifact that our brain in interaction with the environment creates is kind of... not sustainable, I would say. I've always been interested in this, but now I feel it even more so.

(45:42) There's also contemplative experiences that I've had—both in terms of meditation but also some experiences in supervised sessions with psychedelics, with particularly psychedelic mushrooms, psilocybin—where you really get this feeling of being totally connected, or being a part of all this around you. We went up this mountain here in Topanga Canyon and sitting there for hours and feeling that everything moves with your breath and you're really part of this. That entire separation that we create with our sense of self goes away. I think everybody who's done that has had the same experience. So, it's not an isolated subjective thing. It's something that is somewhere stored deep in our mind, that we are part of this.

(46:36) And I think it's a great thing to bring this back. A lot of people will never experience that themselves with the help of psychedelics, but to bring this back into the scientific mainstream, and connect it with these other insights. You know, this enormous number of these microbial organisms—there must be some kind of an intelligence of that system. Just think about hundreds of millions of genes, what's stored in these genes over billions of years. I mean, there must be a tremendous amount of wisdom that I think we're just scratching the surface of this right now. I mean, I can do this now at this stage in my career. I don't have to write a grant about one organism and one molecule. But quite honestly, it's ridiculous to think that we can explain any of these phenomena with that reductionistic attitude.

(47:29) How are we going to study it other than experientially? That's another question. Is this going to be the realm of artificial intelligence, that a human brain can really not conceptualize the complexity? In science, I think that's a likely scenario. I have a feeling. I've talked to a lot of scientists recently, and the answer is always, "Well, if we're going to need artificial intelligence to figure this out. It's too complex." It's so complex on the one side, and it's so simple on the other side. Just do the lifestyle changes, and you'll get the benefit of it. But to figure out scientifically how it all works is going to be tremendously difficult.

Wendy Hasenkamp (48:12): Yeah, that's really interesting to think about. I was going to ask you, you're such an accomplished scientist, and of course all of our current scientific systems are quite built on reductionism and that approach of taking things apart. Which, as we've been saying, is not really going

to get us too far, I guess, when we're faced with the complexity and interconnectedness of reality. It feels like, in a way, when you go deeper and deeper into one thing—certainly, it's been that way, it seems, in your career—you start to expand. If you do it well, you see the interconnections more and more and more. And at a certain point, our current scientific approach seems to break down.

Emeran Mayer (48:56): And I should say, there's kind of two sides to it. Our current scientific approach has worked really well for some things. I mean, like the COVID-19 vaccine development—phenomenal success, saved hundreds of millions of people. Antibiotics were a phenomenal success. And they were based on reductionism. So, it's more these chronic disorders, and to understand the link with what we talked about, with the environmental changes. That you just can't solve with a reductionistic attitude.

(49:31) So I sort of like to divide our diseases or health problems into these chronic non-contagious diseases, which range from some forms of cancer, chronic heart disease, chronic liver disease, Alzheimer's, Parkinson's, on the one side, which is probably our biggest problem. Then, we have the pandemics. For the pandemics, our reductionistic approach is actually pretty good, partially. Even though that doesn't take into account the vulnerability factors which go more into this other category, because people that have these chronic diseases are more vulnerable to the pandemics. And then, we have other diseases, or surgery or acute injuries—medicine has been phenomenal. But it's not doing the same thing for all these different areas. I think that's what we have to realize.

Wendy Hasenkamp (50:27): I know that you are going to be involved in a new film project about the interconnected planet. Do you want to share anything about that?

Emeran Mayer (50:37): So, the film project... the initial film project is actually going to be a documentary on PBS, which will come out in December. And the working title of this is *The Mind-Gut-Immune Connection.* It started with our conceptualization of this *Interconnected Planet* project, which we have put on the back burner for now. We really want to focus on the PBS piece.

(51:00) Yeah, I have to say I've become... maybe "obsessed" is not the right concept. But the concept of interconnectedness, which obviously is at the center of contemplative practices and Buddhism, once you look at the world with different classes, you see, it really explains a lot of the things that we have not taken into account in how we interact with the world.

(51:26) When we conceptualize this interconnected planet project, we wanted not a negative thing showing all the negative things that are happening in the world because that's really depressing. We're definitely at a time where [there are] multiple factors going in the same downhill direction. We want to make it a positive thing, and we sort of conceptualize this as the feminine energy. The difference between the male and the female brain—clearly the reductionism, linear thinking, all the things we see today, are a creation of the male brain. And we're in the midst of this revolution, this paradigm shift towards looking at it more in feminine terms.

(52:08) And I still find that extremely intriguing, and I think it is unfolding rapidly, actually. I would even go so far as [to say] I think that's the only solution to the world's problems. At all the levels—from the politicians, to the science, to the medicine. It just needs to have a balance between this extreme that we've been practicing the last a hundred years. So, I still hope we will make that film. It's just too exciting to think about it.

Wendy Hasenkamp (52:46): Yeah, it sounds really important. When you were talking about the male and female brain, or maybe you could say male and female archetypes, or energy—that kind of a more

broad concept—the male typically being associated with reductionist thinking, or separating things. And then, can you say more about the move towards the female and what is represented in that, at least in this archetypal... You know, I don't want to make too much of a strong division, but I hear what you're saying for sure.

Emeran Mayer (53:15): Yeah. I mean, so there is something obviously going on now in society that we don't talk about male and female, we talk about the continuum. But it doesn't really affect that. So there's a lot of men who have the female archetype, and vice versa.

(53:34) So with women, if you look at evolution, female animals and humans have always had the task of taking care of the offspring. It was the guarantee that the species survived. (And they probably could have done it without the males fighting constantly, you know, so...) *[laughter]* But they also had to nurture and take care and protect the offspring. So, it's a totally different priority, the way they look at the world or have looked at the world. And it goes back to animals.

(54:04) And I think this thinking of connectedness, and not the fight-and-flight patterns, but the tend-and-protect attitude. I think it goes, in simplistic terms, that the female brain looks at the world more in terms of interconnectedness. We clearly, as society—with all these dramatic changes now, the role of women in science and politics and all the professions—sort of taught our female students the male principles. But I think you can really see that women are not just accepting that. They're modifying it based on their own experiences.

(54:45) So, that's the hope. I think there's a phase where females became supermales in order to succeed, but then there's going to be a phase where they're actually going to implement the more feminine view of connectedness and that view of the world. So, that's my sense of optimism.

Wendy Hasenkamp (55:01): Beautiful. Well, thank you so much, Emeran. This has really been fascinating. And I really appreciate you taking the time to share this wisdom with us today. We'll look forward to your future work.

Emeran Mayer (55:13): Yes. Thanks, Wendy. It was really a joy and a privilege to be on the show.

Outro – Wendy Hasenkamp (55:21): *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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