Episode 26 – Variants, Strains & Mutations – Why Viruses Change

With Dr. Jeremy Kamil

Diane (00:00):

You've tuned in to Vax Matters to get answers to questions about vaccines and viruses. So let's get more answers today. Hello, everyone. This is Dianne Deaton. Today's episode explores some complex questions such as what causes a virus to change or mutate? Do all viruses have this capacity to evolve? And how do animals play a role in the mutation or variation of viruses? Here with me again to help us discuss these questions my friend, Clay Young.

Clay (00:41):

Thanks, Diane. It's so great to be here with you. Another week to talk about these, uh, vaccinations. This week's guest is Dr. Jeremy Kamil. Dr. Kamil is a, a wealth of knowledge in virus and disease spread as the Associate Professor of Microbiology and Immunology at LSU Health in Shreveport. Thanks for adding your insight and experience to the conversation today, doc. How are you?

Dr. Kamil (01:06):

I'm fine. Pleasure to be here, Clay.

Clay (01:08):

Uh, let's start at the beginning. Let's explain to our listening audience what is a virus and how it works.

Dr. Kamil (01:16):

Well, uh, some people call a virus a, a little bit of nucleic acid [inaudible 00:01:21] up in either a shell or a, a lipid envelope. Uh, it's basically a self, it's, it's a replicating microbe that, uh, uses your cells to copy itself. It, it doesn't live free, uh, out- outside. Unlike a bacteria or a fungus, it cannot live outside your body. So it's a, it's a little piece of genetic material that wants to copy itself and hops around from person to person or animal to animal or plant to plant or so on. I don't know if that was succinct enough.

Clay (01:49):

No. It was good. And it, it, in other words, it needs a host, and the human body becomes the host and it tries to use the body to feed and then replicate itself.,

Dr. Kamil (01:59):

Pretty much. Yep.

Clay (02:00):

And, uh, people are understanding this now a bit more or at least they're more interested in this now more because of the last two to two and a half years and, uh, we've spoken before about the proliferation of information that's out there, and I'll ask you the same question we've asked others. Where do you direct people that you speak with to get information if they're not speaking with you?

Dr. Kamil (02:22):

Well, I would direct people to just for, for a second slow down and look, look at, um, look where doctors and biology teachers get their information. The very best place would be to look at textbooks that are hosted by the National Center for Biolo- Biolog- uh, Biotechnology Information, to look at the CDC websites, and, um, a lot of universities maintain websites with, uh, basic information on, on virology.

Dr. Kamil (02:54):

Uh, YouTube and, and some social media sites can be, uh, wormholes of in- inaccurate information. If you go in the wrong direction, you can start learning all kinds of things that aren't true, however, YouTube also has very up-to-date accurate information. You just have to know that the source of that information is genuinely an authority, and, and not someone coming out of left field who maybe wants to, uh, get you to believe in a conspiracy theory so that they can sell you a vitamin supplement or some kind of homeopathy that's going to cost you a lot of money, but isn't going to do you any good.

Diane (03:30):

That's why we so believe, doctor, in this podcast. Because that is what we are striving to do to get experts on doctors who live and breathe this, to break it down for easily digestion for our listeners to know what is the fact and you know to, to determine the fact from the fiction from the experts. That's why this podcast we feel is just so critical in today's society.

Dr. Kamil (03:58):

I couldn't agree more.

Clay (03:59):

Yeah. And, you know, talking about these viruses over the last say quarter century, we've heard a lot about AIDS and measles and, uh, smallpox, and obviously now there's a lot of talk about COVID-19 and you, you, just to addressed where to get the information from, what would you say is top of mind the most vital thing you should know about these virus, viruses, uh, apropos to right now?

Dr. Kamil (04:25):

Well, the first thing that I think is really important to know about viruses is, one, not to be ashamed about being sick or, uh, to be overly afraid. Panic is a terrible thing and fear sends people to all kinds of unhelpful places. So I think, first, you should come at it from a place of empowerment. So get information so that you feel stronger and you're behind the driver's wheel and your fear or the virus is not.

Dr. Kamil (04:54):

I think really come at it from a place of giving yourself power over, uh, the thing that might make you sick or uncomfortable. And have a little bit of faith in yourself and your immune system. Uh, we are, we are, uh, ancient beings. We've been on this planet, you know, in one form or another, uh, as part of the tree of life for a very long time and we all have great grandparents and great, great, great grandparents going back a long time. We wouldn't have got here this far if our bodies didn't know how to fight viruses. So, um, vaccines and many other inventions have, have made this even better and protect us from having to lose children to diseases that used to kill a lot… I mean in earlier times

before vaccines and antibiotics, it was routine for families to lose babies and young children to these diseases.

Dr. Kamil (05:43):

And so, that's now preventable. But at the same time, our bodies and our ancestors' bodies have learned to fight viruses. So understand that you already come equipped with some really powerful tools to fight infection and by learning a little bit more about how vaccines protect us and how public health works, uh, from people who actually know what they're talking about, uh, can, can make you feel even more comfortable and use those tools appropriately and also save yourself a lot of money.

Dr. Kamil (06:10):

Uh, by getting a vaccine, for instance, you could avoid a visit to the hospital. And that's scary uncomfortable and also expensive, even if you have health insurance. So there's a lot of avoidable uncomfortable experiences that we can protect ourselves from by learning just a little bit about how the biology works, about how our bodies work, and a little bit more about what these virus things are and how they work.

Diane (06:35):

Excellent explanation, you know, I like it when you said to give yourself a little bit of credit, to, you know, just to be empowered. Don't go under this guise of being afraid or the, the fear or the panic. Don't do that, because our bodies, we are learning. This is kind of a learning (laughs) process for all of us here on this podcast because we're not the experts, you all are. But we are learning so much about how the body responds.

Diane (06:59):

Our bodies are pretty incredible. And as you said through generations and generations and generations, we're still walking the earth. (laughs) We still have our, our family, our grandparents, great grandparents, and our, our family history. So we're doing something right and that's the whole point is to continue to do something right and have, make wise decisions. And I believe that's when you're talking about viruses. What allows them to change or to evolve? That is probably a question on a lot of people's minds, especially in light of COVID-9.

Dr. Kamil (07:33):

Well, I think it's really important for listeners to understand that we're all evolving, even within our body our immune systems evolve and dynamically update themselves to fight invaders. Um, on a scary example of that is how a tumor cell if someone has cancer, it can actually evolve to resist or even, uh, get rid of a chemotherapy drug like push it out of the cell. So there's, evolution can be helpful or scary. So our bodies have evolved mechanisms to fight viruses.

Dr. Kamil (08:03):

Uh, virus… So everything that's alive that has a genetic code is always evolving, however, the speed of evolution can be quite different, uh, depending on the organism. So a virus, uh, especially a pandemic virus that's infecting lots and lots of people is going to evolve more rapidly, because at the end, the viruses have enzymes that copy their genome. Most viruses bring their own enzyme with them, or they encode their own enzyme and that enzyme is usually sloppier than the enzymes that we use to replicate our DNA.

Dr. Kamil (08:36):

Uh, that one of the reasons that we don't have a lot of cancer and that, uh, most people are healthy is that our cells are very careful, um, copying their genetic material when they, before they divide. Viruses tend to be a lot sloppier, but for viruses it usually doesn't matter, because as long as a small subset of the, uh, let's call them baby viruses, are, don't have a mutation that breaks their function or prevents them from doing their job, they don't care.

Dr. Kamil (09:07):

Um, so it's okay for the virus to be a little bit sloppy about copying its genome. And so, when you have a virus like the coronavirus or flu, or flu, uh, or adenovirus out there infecting lots and lots of people, it's going to accumulate mutations. It's important to know that most of those mutations either hurt the virus or don't make any difference at all. But if every once in a while, one little mutation happens that allows a virus that used to infect a squirrel to now infect a turtle or that used to infect a bird to now infect a human, those kind of things can, you know, lead to problems or new pandemics or outbreaks.

Dr. Kamil (09:44):

And then, with coronavirus variants, you can see that because the virus is so out of control and affecting so many humans all at once, it's able to, um… Evolutionary biologists call it exploring sequence space, but what, what that really means is it's, it's picking the lock with, you know, almost like a locksmith with one of those keys that has all the little different variations on it. It's able to try every possible variation even though most of the mutations aren't good, it's able to pull the lever at the casino so many times that it gets a lot of jackpots.

Dr. Kamil (10:18):

And so, when, when, when a virus hits the jackpot in evolution during a pandemic, you get a new variant of con- of concern, let's say, right? So each of these new variants of concern represent an example where a virus has accumulated enough mutations across its genome that are actually helping it. Um, and then, viruses also have complex ways of getting rid of detrimental mutations.

Dr. Kamil (10:42):

So of course, coronavirus compared to other viruses is pretty large for an RNA virus, at least. And when it's accumulating mutations, sometimes it'll pick up ones that aren't good, but then it can recombine with a virus that didn't get the bad ones and, and the, that one virus has all helpful mutations and gets rid of some that's loaded down a little bit, and because there's so many people infected all at once, uh, this virus is getting to take advantage of luck. Uh, that, that's one of the processes.

Dr. Kamil (11:12):

So viruses are just always changing and that's not something to be scared of, usually, uh, but it's something to be aware of. So things, things change at a, at a certain rate. And then, there's also selection pressure. We call that selection pressure in biology, but all that means is, uh, viruses, viruses and all organisms change to fit their environment better.

Dr. Kamil (11:34):

So a famous, um, example from evolution is Darwin's finches. So some finches got from the mainland in South America to Galapagos, and there, they radiated out and some of them evolved to

have beaks that were long. Some of them evolved to have beaks that were short to eat different foods. Um, viruses can kind of do that too, so, but it happens quicker. It doesn't take thousands of years. It can take months or, or one or two or three years. So a virus can, can change to infect the cell in a slightly different way or to change its spike protein a little.

Dr. Kamil (12:10):

And in the case of immune responses, people become immune from being previously infected and where I'm going out with the finch example is, uh, people who've been infected with the coronavirus before will generate antibody producing cells that target the spike and block the spike from getting in. And so, what the virus will do in response by accident, by accumulating mutations, it'll happen to change spots on the spike that escape those antibodies.

Dr. Kamil (12:37):

And those antibodies become part of the selection pressure on the virus that forces it to change in a way that it wouldn't have changed if that selection pressure wasn't there. So the first wave of a pandemic can create a lot of immunity, and then the, the next waves can be driven by viruses that learn to pick that lock. So now there's a new block on the virus and the little lucky mutations that escape those sites that the antibodies like to stick to, now have another chance to grow and spread.

Dr. Kamil (13:10):

So that's, you know, there's, there's just a, there's a lot going on there with mutations. At the end of the day, it's a virus trying to survive just like we all try to survive. If you're a small business owner and all of a sudden amazon.com comes in and sells what you were selling, you learn to sell something different-

Clay (13:29):

Sure.

Dr. Kamil (13:29):

… or you go out of business. And a virus is no different from that. It learns that "Oh, this isn't working anymore." And the one lucky viral mutant that gets past that problem has an advantage over its brothers and sisters. And so, it transmits between people who have antibodies where its brothers and sisters are blocked. And so, that becomes the new branch of the coronavirus family tree that they maybe call the delta variant or omicron, for instance.

Diane (13:53):

So these are all the variants we were talking about then?

Dr. Kamil (13:57):

Yeah. So it's, it's just talking about how mutations are important for viral evolution and just trying to get people to understand mutations are normal. They happen all the time. They happen in our cells. They happen in, uh, in every living thing, plants, birds, um, and usually they are either what we call neutral, they make no difference, or they're detrimental. They hurt the, the mutant.

Dr. Kamil (14:18):

A lot of mutants don't grow as well or they have a problem or they could even be dead. It could be a lethal mutation, but you don't see those, because they disappear from the playing field, if you will.

They're like the football player who got a, a season end- ending injury. He's out of the game. (laughs) So those mutants, those mutations are bad. You don't see them, but, but the general public, I think a lot of folks don't understand or they get suspicious, or they hear some kind of conspiracy theory. "Oh, well, you know, the virus has these mutations that are helping it, uh, you know, who, what mad scientist has released the new virus from the lab? They must have engineered it, because how could evolution produce something that infects people so well?"

Dr. Kamil (14:58):

Well, it's, it's, there wasn't a mad scientist in a lab, there's a slot machine of evolution and, you know, nature is giant and there's a lot of random events happening and the weird random events that are maybe very unlikely that one unlikely event that wins the lottery still wins the lottery. So, so that's, I, I think that's something I wish more people understood is that evolution is all about unlikely events being disproportionately or hugely rewarded by chance just like a gambler in a casino.

Dr. Kamil (15:31):

Uh, no one helped that gambler happen to pull the slot and get the three cherries and make the jackpot. Um, usually, it's not a scam. That, that's just the one lucky person, but you could never guess going in which of the 10,000 people pulling the slot are gonna get the jackpot. Same with evolution. It's, it's about luck and chance.

Clay (15:51):

Wow. That's, uh, a, a fascinating answer. So, and you kind of answered one of our next questions about why viruses mutate and, and you said it's trying to survive and some of the mutations kill it and some make no difference and some allow it to be around. Um, let's talk about that in context to vaccinations, because as time goes on, you talked about how things evolve, and then you introduce a vaccine into the situation versus the attempt to mutate. Kind of talk about that in relation to where we are.

Dr. Kamil (16:23):

Well, vaccines are actually really useful for slowing down viral evolution. And that may sound, um, funny to people, because, all right, if you vaccinate against say the coronavirus spike, you're giving people antibodies that block the spike from infecting them. And in theory, a virus that mutates to get past the vaccine would do better than, um, a virus that didn't. So some people would say, "Oh, well, the vaccines create variants." But that actually is wrong.

Dr. Kamil (16:51):

Um, if you actually do the math and talk to experts who do the modeling. When you vaccinate a lot of people in the population what happens is the virus has less chances to pull the slot machine lever, because when someone already has a defense system erected against the virus, even if the virus gets lucky and, uh, has a mutation that makes the vaccine a little bit less effective, that person's prior immunity is going to limit the number of times the virus can replicate in their body, because the vaccine doesn't make just one antibody appear. It makes dozens of antibodies appear that hit the spike in different spots.

Dr. Kamil (17:29):

So even if the vaccine fails, if three or four of those spots no longer match up, the other five or six probably still do. And on a population level when you're dealing with, let's say if Louisiana was better

at getting its citizens immunized, I think we're actually unfortunately one of, uh, the poorer states at getting people, uh, above say 50% fully vaccinated, but the more people you get vaccinated, the virus gets boxed out and it doesn't have a chance to pull the lever and replicate enough times and people to make those mistakes that on only a soft small subset of those mutations or those typos are lucky.

Dr. Kamil (18:05):

So what I'm saying is that vaccines limit viral evolution because they limit the chance that a virus is going to be able to infect a person for a very long time. Another level of this that gets complicated is that we know that the coronavirus evolves more in certain individuals than others. So it evolves more let's say in people who are immunocompromised or let's say someone has untreated HIV/AIDS, uh, or for, for some reason has a genetic problem with their immune system that, that prevents them from making really good antibody responses.

Dr. Kamil (18:37):

When the virus finds one of those folks, it can live in their body for longer and if they make a weaker immune response, then the virus has a more comfortable environment to kind of experiment a little bit and try different mutations until it finds a jackpot. Because it can, it's basically allowing the gambler to play in the casino for longer and giving them more chips to pull the lever. So on a population level, if lots of people are immunized, the virus has a hard time hopping between different people until it finds one of those lucky casinos that stays open late. (laughs)

Dr. Kamil (19:10):

And by that, I mean the immunocompromised person. So it's really, really important in vaccine, uh, strategies when states and countries, uh, get people immunized, to get as many people as possible immunized. And so, that's why it's really, it make… That one of the words for that is herd immunity and people say, "Oh, well, the coronavirus, we can't count on herd immunity to protect us."

Dr. Kamil (19:34):

And to a, to a degree they're right, because respiratory viruses are, uh, you don't tend to see as long and durable immunity against infection. But they're also kind of wrong because when you already have immune memory, when you, when your body already has been educated how to fight a virus, even if your antibody levels decline, which they will do over time and that's a good thing. That's normal. Um, because if, if your antibodies didn't decline, your body wouldn't be able to fight other invaders. You know, your body has to kind of invest dynamically to protect itself, but people who have immune memory, there's something called memory recall.

Dr. Kamil (20:10):

So even people whose, uh, antibody levels have waned, who are vaccinated, if they get infected, they're going to be faster clearing the virus, because they're going to recall all those B cells in their memory that make antibodies. So they're still going to fight off the virus faster than someone who's not immunized. And I, I guess my larger point is the mo- the more people who get vaccinated against flu or coronavirus, the, the more days you can keep a school open, because the teacher's not going to get sick and more and more and more kids are not going to be ill and missing a day of school, uh, you know, whatever your thoughts are politically one way or the other about vaccination, it's indisputable that the more people who are vaccinated the less days that workers will miss work and the more days that schools can be open and small businesses can be open and that translates to a stronger economy.

Dr. Kamil (21:01):

So I don't think vaccination should have a political angle to it at all. It's like asking if it's a smart idea to have wheels on your car (laughs) or to keep them inflated.

Diane (21:08):

True.

Dr. Kamil (21:09):

Uh, this is not a debatable thing. Um, or is it smart to drive, to leave your driveway with an empty, uh, tank of gas or a full tank of gas? I don't think that, you know, Republicans and Democrats differ about, "Hey, if I want to drive far it's good to have a full tank of gas." Um, you know, or "Hey, uh, if I'm wearing an umbrella, uh, it's, it's better. If I have an umbrella with me today, it's better if there's a rainstorm than if there's not. That shouldn't be a political thing, right? Um, or if it's cold out, it's nice to have a jacket.

Dr. Kamil (21:37):

I don't think that, you know, the two political parties are having any debate about that. And so, it's kind of sad because of all this online misinformation that people are starting to have, you know, political alignments about masks or vaccines when these are just basic things that everyone should just agree are smart to have.

Diane (21:54):

Mm-hmm. You know, I think that brings up a point too, doctor, that the early days of COVID… I'm just going to speak for myself. When this first came out in early 2020, it was, it was disruptive, but I thought, "Oh, this is going to be over by the end of the summer. This isn't going to last long. This is not a big deal."

Diane (22:12):

And then, it went on and on. And now, we're in, in 2022. And I, I think it, it kind of gets to a degree that, that people, it is wearisome. We, you, you have to, you, we still need to know about it, we still have to understand it, but people are kind of weary of it and you say, "Okay. Well, if everybody is doing, uh, their part, why are there so many variants? What's going on here?" Something, you know, you have the naysayers [inaudible 00:22:41]. If you did this, you did this, you did this, then why do you have the delta variant? Why do you have the omicron variant? What's going on? What is not being addressed that we continue to have the variants? I, people are asking that.

Dr. Kamil (22:56):

Well, I mean it's a fair question to ask. Uh, what's unfortunate is when people take a basic observation and use fear and, um, logical fallacies to fool people into thinking, "Oh, well, they told us the vaccines would protect us, but now there's omicron and vaccinated people spread it. So the vaccine is useless, you shouldn't get vaccinated."

Dr. Kamil (23:18):

And that would be, that's an example of a logical fallacy. It's absolutely wrong-

Diane (23:22):

Mm-hmm.

Dr. Kamil (23:22):

… um, in the sense that the first part is correct. You can find examples of where delta was spread between vaccinated people. You can find, even boosted people, you can find examples, definitely, with omicron where boosted people caught omicron and spread it to another boosted person, however, if you really look at the graphs and you look at the numbers of infections, you can still see the vaccines protecting people from infection and especially if you look at hospitalization and severe illness, the vaccines are a resounding success, even against omicron.

Dr. Kamil (23:55):

Now I'm fully in favor of updated vaccines that are a better match to omicron, and I hope that those investments get made. I know Germany's buying updated doses. I hope our country can afford to do that as well. Uh, but the people who go from one anecdote or one little story of a vaccine failing to some expansive statement about vaccines being useless. Well, they've really fooled you. And often these same people have a product they'd like to sell you. Some, you know, vitamin supplement or a book about how a keto diet or a protein diet or exercising more will protect you from infection, which is absolutely false.

Dr. Kamil (24:33):

Um, Ebola and flu and coronavirus (laughs) can take a perfectly healthy person and make them very ill.

Clay (24:39):

We've seen it.

Dr. Kamil (24:40):

And it often-

Clay (24:40):

Mm-hmm.

Dr. Kamil (24:41):

It often has nothing to do with how fit you are-

Clay (24:44):

Yeah.

Dr. Kamil (24:44):

… how many miles you run. Age can make a difference, um, and being fit, going into a disease is always better than not being fit. So it's not like, "Hey, being fit's a bad idea or can't, can't, uh, necessarily, uh, provide a benefit." Uh, of course like a diabetic person who've been overweight for many years is gonna have a worse outcome on average than someone who's healthy. But that, that logic doesn't extend to if I jog 10 miles a week, I'm going to be immune from coronavirus or flu. That's absolutely wrong and there's definitely examples of athletes in top shape getting taken down by flu, by coronavirus or all these things.

Diane (25:24):
And taken down quickly, quickly too.

Clay (25:26):
Yeah.

Dr. Kamil (25:26):
Taken down quickly.

Diane (25:27):
Mm-hmm.

Dr. Kamil (25:27):
Hard for scientists to predict and physicians to predict who's going to get very sick and who's not, because our bodies have dozens and dozens of genes that play roles in fighting infections and you or your family may have a slight difference in one of those genes that makes you better at fighting one virus and a little worse at another. And so, it's like shuffling a deck of cards. It's really, really hard to predict with this new coronavirus or even viruses we know better like flu, what are the genetic determinants of why someone at a certain age and BMI and fitness level will become very, very sick even though they look like they're fit and another person won't, won't hardly notice it, even if they weren't vaccinated. And we know that's already true.

Dr. Kamil (26:08):
So there's a lot we don't know. What we do know is that vaccines take people who would have gotten very sick and make it so that they have, if anything, a mild illness or maybe a moderate illness, a really bad fever when they otherwise would have been in the ICU on, you know, steroids or having to get a lot of advanced medical care to have a fighting chance to survive. We had a, uh, a congressman here, Luke Letlow-

Diane (26:32):
Yes. Yeah.

Dr. Kamil (26:32):
… who up, up, up in Monroe area who got sick and he was, he was flown into Shreveport and they couldn't save his life. He was in his early 40s, and his, his wife now has his seat in Congress.

Diane (26:45):
Yeah.

Dr. Kamil (26:45):
So I think that's a good testament. He, he wasn't a really, he wasn't an overweight guy. He was a normal looking, you know, trim average, uh, build adult, looked very healthy, um, and I think it just goes to show you cannot predict when this virus will cause severe illness and your best bet is to get vaccinated and that's going to protect you, it's going to protect your kids, your spouse, your family, the, the, the folks you do business with, you talk to, you have meals with.

Dr. Kamil (27:10):

You don't be spreading a virus to someone, uh, and making them sick and even if a small number of people who, um, maybe were vaccinated can spread omicron and you can find an example of that. There's also a lot of examples where people who are immunized don't spread it well, because even if they get a little sick, their bodies are already fighting it much faster than if they weren't immunized.

Dr. Kamil (27:30):

So it's, it's really just important to understand that vaccines are a huge help and those, that's one of the most important public health achievements in, in the history of man, and humankind, is, is immunization. Bang for the buck, the cost of a dose, of doses of vaccines to prevent an expensive hospitalization or needing advanced medical care. When you give vaccines, you protect our economy, and you protect your family, uh, from having a big inconvenience, or a tragic, uh, early death or, you know, all kinds of costs associated with vaccine preventable illnesses.

Clay (28:10):

Huh, you know, you talked a second ago about the evolution of these, these viruses and I'd like to ask about whether or not it makes them more dangerous or if it's a guarantee that as it evolves it will become more dangerous.

Dr. Kamil (28:24):

Yeah. That's a tricky one. So people fit, people, uh, have this idea that viruses always become less dangerous over time. And there, I think there are examples where viruses start to look less dangerous over time, but if you look at those examples, they often, um, caused a lot of death in those say animal species like rabbits. Like myxoma virus in, in Australia killed lots of rabbits, um, people tried to bring in a virus to take out the rabbits and the rabbits and, and the virus ended up kind of in an equilibrium, but you wouldn't want to see a situation where, uh, five billion people died and we left behind the few that were resistant. (laughs)

Dr. Kamil (29:11):

And you look at vi- and you look at bacteria like tuberculosis. It's just as deadly today as it, as it was for, you know, millennia. You don't want to catch tuberculosis. That's an endemic disease. So we have no way of basically saying in a blanket fashion, you can't make a blanket statement that viruses and, and microbes that cause disease will become less deadly over time.

Dr. Kamil (29:35):

Um, what is clear is that, uh, it can go in either direction. So one variant might cause more disease the next variant might cause less and then the variant after that might cause a little more a lot of this has to do with luck and a lot of the reduction disease for coronavirus has to do with our immune system, not the virus. We can see that very clearly in Hong Kong where they only used, uh, this not very effective version of a vaccine that was never approved here.

Dr. Kamil (30:08):

I think it's, uh, is it called CoronaVac, Sinovac? I think is what it's called. So that's inactivated coronavirus particles. It's actually the real virus and they've, um, treated it with chemicals so it's, it can't infect cells. And they immunize their elderly folks with that Chinese vaccine that wasn't very effective, and then when omicron got into Hong Kong, you saw a lot of deaths. And but if you see omicron in the United States or in parts of the world that didn't control, that, that didn't do a good job

controlling the virus early on, and/or had vaccines, you see much less death in that same age segment.

Dr. Kamil (30:46):

So what that tells you is that people, uh, who didn't get immunized or didn't get previously infected, omicron was really dangerous in their elderly population. So a lot, there's a lot of misinterpretation of, "Oh, the viruses evolve and they become milder." No. Our, our immune systems are getting educated one way, uh, or the other, uh, either, by getting infected getting vaccinated or both to fight the virus and that means that more people survive it and there's fewer hospital admissions.

Diane (31:16):

You know, some words we've been using today, we've talked about or you've talked about mutations and variants and strains. What, what's the difference? All maybe under the same umbrella or can you clarify that, Dr. Kamil?

Dr. Kamil (31:35):

Yeah. So in the pandemic, we've taken… The scientific community has more or less informally agreed to call new versions of the coronavirus, the COVID, the coronavirus that causes COVID-19 which is called severe acute respiratory syndrome virus II. We call, uh, we call a new versions of that virus variants, because it's a more conservative word. Uh, when you use the word strain, it tends to imply that people in laboratories have done experiments to show that phase two viruses are really biologically different siblings of the same virus species.

Dr. Kamil (32:19):

So because a lot of the times those experiments haven't been done, it's just easier to use the word variant because it's not asking as much scientifically as, but in the end of the day, these are just words.

Diane (32:32):

Mm-hmm.

Dr. Kamil (32:33):

If a, if a person on the street calls it the delta strain or the omicron strain, I'm not going to get upset at them.

Diane (32:39):

Yeah.

Dr. Kamil (32:39):

If it's another scientist writing a paper and I'm reviewing it, I'd say, "Hey, you know, it's proper nomenclature to call it a variant." So I wouldn't get hung up on that to your-

Diane (32:48):

Yeah.

Dr. Kamil (32:48):

… to your listeners or readers. We like to use the word variant, because it encompasses strain as well without having to prove that it's really biologically different as a strain. I think it is fair to say that delta and omicron, uh, are different strains of the coronavirus, but we've just gotten the habit of calling them variants.

Diane (33:07):

Mm-hmm.

Dr. Kamil (33:07):

And it's more of a, a language and culture thing than I think a scientific thing at this point.

Clay (33:12):

How do you track the changes?

Dr. Kamil (33:15):

Well, that's a great question. So the easiest way to track the changes is, uh, genomic sequencing. So, um, technology, in the old days before we could, you know, do genome sequencing so quickly and, and inexpensively, uh, you would have to do experiments or look at, do study the proteins using biochemical assays in a lab to show that they migrate differently on a gel or that the viruses grow differently on this cell or that cell, but nowadays, you can.

Dr. Kamil (33:49):

Because, the, the beautiful thing about viruses, one of the reasons that I kind of fell in love with them and, and decided to study them for my career is that you can boil them down to just their genetic code very easily and you could, you know, once you have the virus genetic code, you could reintroduce that to a cell and it's just like having the software program to run, you know, the Macintosh or the Windows operating system.

Dr. Kamil (34:12):

It's all there in the code regardless of, you know, if you put it onto a new hard drive, it behaves the same, right? As long as the chip is there and everything's good viruses are very simple. So if, if you read the, the genetic code from one end of the genome to the other, that gives you the ability to understand all the proteins it can make and you can look at how the, uh, nucleotides would be translated to amino acids to make the spike, for instance.

Dr. Kamil (34:40):

And so, people can really quickly take a swab from a patient, uh, extract the nucleic acid and then do some techniques in the lab and put it on a sequencing machine and read the entire genome from one end to the other. And if you do that for thousands and thousands of coronavirus samples over the pandemic, and there's now over 10 million that are shared on the, the site called GISAID, G-I-S-A-I-D. You can see during the pandemic, most of the changes that have happened are on the spike.

Dr. Kamil (35:08):

And what that tells you is that the spike gene is, the, or the spike protein, which is encoded by the spike gene is a really, really important target of selection. And a lot, and there's a couple things going on there. I don't need to get into the, the weeds with it, (laughs) but it's, this virus is adapting to infect people better and the spike is the major part of the virus that allows it to infect human cells.

Dr. Kamil (35:32):

It's also the major target of antibodies that block infection and, um, although there are T cells too, and those are really important in, in protecting your body especially from severe disease. Only antibodies, specifically neutralizing antibodies can block the virus from infecting you at all. And so, you could… So the, the easy way to tell what variant you have in a, you know, in a patient's nasal swab or whatever method you have of getting the virus sample from a sick person is to read the genome from left to right end, and decode it, and then look at how those, those changes would affect the spike protein as well as some other little spots in the genome that kind of tell you who this virus is grandma and grandpa, (laughs) because there's, there's basically people who are called genomic epidemiologists.

Dr. Kamil (36:21):

They are, they specialize in using computer programs and understanding of, of how things change over, how genomes change over time to make an accurate family tree. And so, sometimes those silent mutations can help them understand, you know, who's this one's great, great, great, great, great, great, grandpappy versus, you know, this other one. Um, so those things together can give you the lineage like, you know, the, um, the lineage of the virus while there's another subset of mutations that we call convergent.

Dr. Kamil (36:52):

So many different variants around the world will independently acquire certain changes to escape antibodies or say bind to human cells a little better, enter human cells a little better and because those mutations happen over and over again, they can't help you make a family tree, which means you can't necessarily use those things alone to place a variant. Of course, now everything is omicron, basically. (laughs)

Diane (37:14):

Mm-hmm.

Dr. Kamil (37:15):

So, so, uh, the game changes from time to time as we get a, you know, we call it a, a evolutionary sweep or a sweep. So when a really, really fit mutant comes out or a variant comes out it, it out competes all of its siblings and, and clears the table of other variants. And right now we're, um, probably at the end of the omicron wave and who knows if future variants are all going to be omicron's daughters or whether, you know, some weird puddle of delta is still hiding out there or some early, early virus is hiding out in some, you know, we know this virus is in deer now.

Dr. Kamil (37:52):

Um, and the world's really big, you know, there's a lot of places we don't do genome sequencing and we don't have good health, reach of health systems into certain populations around the world in poorer countries. So there could be some earlier variants still stirring around somewhere and that's how omicron popped out so who knows what's next.

Diane (38:10):

Well, would you talk about the role of animals within, with within this topic, you know? We were talking about, is it zoonosis?

Dr. Kamil (38:18):

Yeah, zoonosis.

Diane (38:19):

Okay. What, what does, because we thought, you touched on it briefly, uh, can you explain that too, doctor?

Dr. Kamil (38:26):

So zoonosis is actually pretty interesting in the sense that a lot of the nastiest infections, a lot of the most, uh, serious viral diseases are often zoonotic. And that means hops from an animal to a human. Flu is a good example of that, um, you know, most people think influenza think that's a human virus, but in reality, that virus-

Diane (38:50):

It's not? Oh, I thought it was.

Dr. Kamil (38:52):

It actually evolves in birds every year-

Diane (38:55):

Really?

Dr. Kamil (38:56):

… and it has, um, and, and waterfowl I think is, are the lead suspects. It also evolves a little bit in pigs. Um, and it has, it has a segmented genome. The coronavirus is just one piece of RNA, just a giant about 30,000, uh, letters long of nucleotides. Just shy, just shy of 30,000. The, the flu, the flu genome's eight genome segments and they can shuffle. And there's, some of those segments, um, if, if you get like a bird that's co-infected with a few different flu variant, uh, flu strains, they can shuffle their, their H segment and their N segment, and some of those segments really impact what species the, that virus can infect.

Dr. Kamil (39:43):

And, um, so when you talk about zoonosis, the, the flu virus shuffles its genome every year from circulating flus that a lot of them never infect people, but are, but they'll co-infect in a, in a maybe a, a goose or a duck and a lucky, and two, two different flues will be in the same cell at the same time and they'll, they'll shuffle their, their, their genome segments and you can get one popping out that just happens to be able to infect people.

Dr. Kamil (40:14):

And that, and that one, you know, maybe someone brings a bird to a market and gets infected and then if that virus is able to infect from human to human, then you can have a new flu strain for that year. So, um, the companies that gen- that make flu vaccines try to monitor the inf- the infections I think in people in Australia and China early in the season, because their, their winter in Australia is the same as our summer.

Dr. Kamil (40:42):

So they try to get a read on what viruses are percolating around. I don't know if they look in the waterfowl. I'm not an expert in flu, but I think they look at what viruses are out there and they try to predict what, what the flu might look like next season and they make what they call a multivalent vaccine that has a blend of different, uh, it's a best guess of what, what could be infecting us next year and that's what they make the vaccine with.

Dr. Kamil (41:08):

But back to zoonosis, when a virus exists mostly in, in birds, oftentimes, and this is where some of that idea about, "Oh, well, the virus will evolve to become less dangerous." Well, when a virus lives routinely in birds, and then spills into humans, it has maybe a reached equilibrium with the birds, maybe killing lots of birds in the process or provoking the birds to make a strong immune response that the birds don't get really sick. And then, it spills into people.

Dr. Kamil (41:37):

That virus has no equilibrium with us. It's not in balance with us and if it kills a lot of people, the virus doesn't really care, because it's still going to get to live in the birds and the pigs. So, uh, there's a lot of examples of zoonotic infections being more dangerous. HIV is another one. So HIV came from viruses that lived in primates, and then through maybe people gathering bush meat, it got into humans and that virus, you know, eventually ends up being quite deadly to people who don't treat their HIV infection.

Dr. Kamil (42:10):

Now HIV is an example of a virus that, and so is the coronavirus. Those are both zoonotic infections that became human viruses, because now HIV has evolved so much in humans that's no longer a primate virus. It's now permanently a human virus. Um, flu every season it bursts out of the, uh, the birds, and recombines and shuffles up and, and throws off almost like a spark from a fire a new little human virus that goes and makes a lot of us sick, but that's not the natural history of flu is mainly, uh, an animal virus that just sends off something that can infect people.

Dr. Kamil (42:48):

Uh, another great example of that are the arboviruses as we call them. There's a virus called West Nile virus that came here from, uh, I think it was originally first described in Uganda, but it, it swept through Europe, and then in 1999 there were some crows that were dying at the Bronx Zoo and the veterinarian was smart enough to say, "Why are all these wild crows just collapsing?"

Dr. Kamil (43:13):

And so, he had, um, some samples sent maybe to the CDC. I don't know where. And they figured out that these crows had West Nile virus and West Nile virus had never been seen in North America before. And what, and so it circulates between birds and mosquitoes, and it can replicate in the mosquitoes, in can replicate from the birds and birds migrate. So it got spread all across the US. And then, what happened was just like those crows got sick, because those crows even though they are a type of bird, they aren't the type of bird this virus was usually growing in. So it wasn't in balance with those birds and it was making them quite sick.

Dr. Kamil (43:47):

It actually happens to make the barred owls quite sick, and it, it replaced a virus called St. Louis encephalitis virus that used to be in North America circulating between birds and, and mosquitoes.

So it's a bird vi- bird, mosquito virus and when those mosquitoes happen to bite a human, we can get sick and West Nile virus specifically makes elderly people quite sick. It kills. I think it's killed probably nearly, uh, 2000 elderly people since, uh, since 1999 or so.

Dr. Kamil (44:18):

And it goes into the brain. It can, it can cause a neuro-invasive infection. So that's a zoonotic infection, and, and part of what that is, is that this virus doesn't have any need to transmit between humans. So it can be in some ways more deadly because it's, there's no responsibility of the virus to live, to keep you alive long enough to even spread it to another person. You, you can get very, very sick and die really quickly and it's no skin off the viruses back evolutionarily because it lives between birds and, um, mosquitoes.

Diane (44:56):

Mm-hmm.

Dr. Kamil (44:57):

And there's, there's another class of that one called, another arborvirus called Eastern Equine Encephalitis virus that moves between, uh, and it's called equine, which means horses. So you think, "Oh, it's a horse virus." No. It's another bird, mosquito virus and the horse acts like a canary in the coal mine. You'll see horses getting really sick, and then that's kind of a sign that the virus is around and when it get, that one when it gets into children can, can kill one in three who gets sick.

Dr. Kamil (45:24):

So, um, West Nile tends to hurt the elderly, Eastern Equine Encephalitis is, is much less common than West Nile, but it, it causes children to, uh, experience near, near fatal encephalitis, which is a brain, means the virus infecting, is infecting the brain.

Diane (45:40):

And that's through a mosquito bite too? Is that-

Dr. Kamil (45:42):

Yeah. It's transmitted by mosquitoes.

Diane (45:44):

Gosh.

Dr. Kamil (45:44):

Um, and it can replicate in the mosquitoes and in the birds, but it lives in a, it lives going back between the mos- It probably doesn't make the mosquitoes get sick at all, and it, it only, and some birds probably like finches and sparrows and whatnot maybe it doesn't make them sick at all, but it, it, it makes barred owls sick.

Dr. Kamil (46:03):

I actually learned from the veterinarians down at, uh, LSU vet school, that they, they get a lot of, uh, good Samaritans bringing barred owls that are kind of laying on the ground half alive and it turns out that they get quite sick from West Nile virus just like humans do. So, uh, people, I, I would hope that

we should make more investments in, in genomic sequencing of viruses, because it lets us know what's happening out there, how the virus is changing, and learn what to watch out for.

Dr. Kamil (46:34):

So, and, and it's much nicer than just knowing that West Nile virus is there, because a lot of the earlier types of tests available to us in 1980 would just tell us, "Oh, uh, the, you know, the mosquitoes are positive for West Nile." But it doesn't tell you anything about how the virus is changing or evolving. And, and so I think it, it would behoove us to make good investments in using genome sequencing to track all these things that can cause disease, even if it's only, you know, a few hundred people dying a year, I think it's important to keep track of that because it could quickly change from a few hundred people to a few hundred thousand people, and having an early warning could, could make a difference in updating vaccines, diagnostic tests, and whatnot.

Clay (47:16):

Wow. (laughs) Wow. Wow. Wow. Uh, a fantastic episode and we want to thank everyone for listening with us today and, uh, Dr. Kamil for you sharing so much of your great insight with us. We hope that everyone enjoyed it and we'll come back for the next episode. Diane Deaton, I'm Clay Young, see you next time.