Evelyn Lamb:	00:09	Welcome to the Lathisms Podcast. I'm Evelyn Lamb. In each episode we invite a Hispanic or Latinx mathematician to share their journey in mathematics. Today I'd like to welcome Mariel Vazquez to the show. Hi, I'm glad to have you here.
Mariel Vazquez:	00:23	I'm very glad to be here.
Evelyn Lamb:	00:25	Can you tell us a little bit about yourself?
Mariel Vazquez:	00:28	Yeah, so my name is Mariel and I'm a professor of mathematics, and of microbiology, and molecular genetics at UC Davis.
Evelyn Lamb:	00:36	Your research area is so fascinating. Can you tell us a little bit about that?
Mariel Vazquez:	00:41	Yeah, I work at the interphase of mathematics and molecular biology, and I am very interested in the structure of DNA and how this molecule, which, as you know, carries a genetic code of an organism. I'm interested in knowing how it folds in three dimension space and how its geometry and topology changes under the action of enzymes. Enzymes are proteins that catalyze a reaction, and they are interacting with DNA all the time. When enzymes bind to DNA and cut DNA, as a byproduct of that cutting, we see a topological change or a conformational change, and we are very interested in understanding the action of the enzyme, the mechanism, and what effects it has on the shape of DNA.
Evelyn Lamb:	01:33	Do you have a favorite math tidbit that you'd like to share with students or with people who don't think of themselves as quote unquote "math people"?
Mariel Vazquez:	01:43	Well, from my research I have been working for many years on trying to understand these enzymes that change the topology of DNA, and the first impulse for someone outside the field would be, "Oh well that's just something that mathematicians made up but it's not real or it never happens." So the interesting tidbit here is topology is incredibly important for DNA, and if you're a mathematician you know that if you're talking about topology of a curve, the curve needs to be closed. Otherwise, every curve, if it's not closed, is identical to any other curve. But the moment you have a curve that is closed this curve could be noted or could be interlinked with another curve and the different knot types have different properties. Well, this happens in DNA.

Mariel Vazquez: 02:44 DNA molecules are often circular in bacteria, in archaea. There is many organisms that have circular DNA including humans. Inside each human cell there is mitochondria, and mitochondria have circular DNA inside them. Even though our chromosomes are linear they are believed to be organized into small loops, so locally they behave like circles. So that's the first important fact to realize, that DNA very often behaves like a circle, so it makes sense to ask questions about its topology.

Mariel Vazquez: 03:24 And then the next thing to realize is that every time a cell is going to divide, and this happens every couple of hours in bacteria. It happens every day or so in humans. Every time a cell is going to divide it has to open up its DNA and copy it. Well, if the DNA is a circle the moment you open it up and copy it inevitably you end up with two linked circles. And so you have there a topological shape, you have a link, a mathematical link, and this link needs to be unlinked before the cell can divide and each daughter cell can incur a chromosome. So these are very interesting questions. How do enzymes manage to unlink the DNA? How do they do it so quickly? What mechanism do they use? And for that we use tools from knot theory and low-dimensional topology.

Mariel Vazquez: 04:29 This is an example where there's a very important biological question, and the tools that we use to tackle the question come from pure math, and not only that but the biological question has inspired new mathematics, has inspired mathematicians in low-dimensional topology to prove theorems that are relevant to the work in DNA topology.

Evelyn Lamb: 04:57 So kind of a beautiful feedback loop there of math helping biology and biology helping math.

Mariel Vazquez: 05:04 Exactly.

Evelyn Lamb: 05:05 Yeah, that's something that I think everyone, when they start learning about topology and they hear that it can be used for DNA I think it's just something that's so fascinating to people.

Mariel Vazquez: 05:15 Yeah, well that was definitely my case. I always liked mathematics and I liked molecular biology, but I couldn't see how to put them together. And when I found this application of knot theory to DNA I completely fell in love with it.

Evelyn Lamb: 05:32 Maybe we can back up and talk a little bit about how you did find this career path. Yeah, how did you start with that?

Mariel Vazquez: 05:41 Well, growing up I didn't know that one could become a mathematician, but I really liked math and I was reasonably good at it. I was always looking for patterns in numbers, in shapes. At that time I thought if you wanted to become a mathematician ... I didn't know that that was a thing. I thought if you liked math then you naturally went into engineering, but when it came time to go to college I realized that one could study mathematics, but I also really, really liked molecular biology. I had just studied DNA in high school, and I had studied the central dogma of molecular biology, and I thought all that was fascinating. So even at that young age I started playing with the idea of applying mathematics to molecular biology, and I wasn't sure if that was possible. Talking to people, to other scientists, I realized that yes, it was possible. It was a good idea, but there was no straight career path to take me to where I wanted to go. I had to either study math or study biology and aim to see the meet later on in graduate school.

Mariel Vazquez: 07:02 So I made a decision to study mathematics, and I started studying mathematics, and then as I went through the course work I realized that I really liked pure mathematics, and the applied math courses were interesting but they were not as fascinating to me as a pure math courses like graph theory, combinatorics, topology. So in my naivety at that age I thought, "Well, if I like pure math over applied math, how in the world am I going to apply math to biology?" So I just thought I would need to keep biology as a hobby, as reading in my free time, and just pursue topology which is where I was really finding a passion.

Mariel Vazquez: 07:51 And then one day walking through a corridor at the university I saw this poster that said "Knots and DNA" and that was exactly the math that I liked with exactly the biology I liked. The poster was advertising a series of talks given by De Witt Sumners, a professor of Florida State University, and these talks were taking place in the mathematics institute at the National University of Mexico, and I thought, "Okay, well I'm going to see what that is." They were aimed at the very high level, and I was just a sophomore in college, but I went to the talks, and I absolutely loved what Professor Sumners had to say, even though it was completely over my head, and I couldn't understand any of the details, but I knew that that's what I liked. So, that's how I landed in what I'm doing today.

Evelyn Lamb: 08:48 So a sign from the universe that this was something that you could do.

Mariel Vazquez:	08:52	Absolutely.
Evelyn Lamb:	08:54	So when you were growing up, it sounds like you knew that you liked math and science. Who encouraged you to pursue math and science as a career?
Mariel Vazquez:	09:04	My dad is an engineer, my grandfather was an engineer, so liking mathematics was in the family. It was praised. My mother did not do so well in math herself, but she really admired people who were good at math, and she recognized very early on that's something I enjoyed and I was good at. She made sure that any society bias against women in math would not come through to me. She was very, very encouraging of me doing math and science all throughout my childhood and teenage. There was always the example of my father and my grandfather, like, "Oh look, they're so good at math. You can also do it. You can be great at math."
Mariel Vazquez:	10:02	So I would say at home my parents were the biggest encouragement, and later on, of course, at the university ... In school things were mixed. There were people who encouraged me to do math, people who didn't think I could do math because I've always been very detail oriented, and since I'm very detail oriented I move very slowly. And somehow school seems to value efficiency and speed sometimes over creativity. So because I was not able to work fast some people thought, "Well, maybe math is not for you," but I guess they were wrong.
Evelyn Lamb:	10:49	Yeah, so further along in your education and in your early career, did you have mentors and people like that who helped you find your winding path through math and biology?
Mariel Vazquez:	11:04	Yeah, I've had more mentors and people who have been an inspiration to me than I can list here. There has been, starting with teachers at school and during my university years there were a lot of really amazing professors at the university who were always encouraging. They were also illustrating what being a mathematician was by example, and I really, really liked what I saw. I liked that these people loved their field of study, and they really liked educating. They enjoyed interacting with students. They enjoyed helping students. They had a very strong sense for social justice, and all that made a composite image of what a mathematician was that I really liked and that kept me moving forward in my career. Fairly early on in my college years I decided, yes, this is what I want to do. I want to become a mathematician, and I want to stay in academia and educate people and do research.

Evelyn Lamb:	12:25	And I know no career path is without its bumps along the road. How have you overcome challenges in your career?
Mariel Vazquez:	12:36	Well, I think in math and also in life in general for me it is a matter of putting one foot ahead of the next and just keep walking. If I could put this in one word the key word is resilience. I've had a lot of challenges, personal and professional, but I just choose not to linger on them. Usually when there is trauma, psychologists say that people go through several phases, and the first two phases are denial and anger, the "why me" and being angry at what's happening, and I just keep those two phases. I think I'm lucky that way that I don't linger on things that happen to me or injustices. I just keep going and choose not to pay attention. Go straight, and accept, and start problem solving whenever there's a challenge.
Evelyn Lamb:	13:46	And what have some of those challenges been for you?
Mariel Vazquez:	13:50	Well, I think from the moment that you choose to do mathematics and there's no other women around, comments that people make. I always give people the benefit of the doubt. I always think that people don't have bad intentions so I just choose not to pay attention, but I've realized throughout my career that some people, especially people who are in the minority, sometimes they spend too much time thinking about the injustices around them and suffering from them. I think we need to think about the injustices, reflect on them, and find a way to change the status quo, but lingering in the injustice is not productive. So that would be an example like sexist comments or any form of discrimination that you might find in the workforce or out in the street. Well, just move on.
Mariel Vazquez:	14:57	I have dealt with illness, and when that happened I just felt, "Well, maybe this is the end. I won't be able to continue being a productive mathematician. I won't be able to do my research." But there were always ... As you put it before, there were always signs from the universe coming my way saying, "No, no, no, you cannot stop. You need to keep going. This is not an excuse to stop", and then I just keep going.
Evelyn Lamb:	15:29	And is there a moment in your career you've been most proud of?
Mariel Vazquez:	15:33	Oh, well I think probably my proudest moment, from a selfish point of view, is when I received the Presidential Award, the PECASE award, and I went to the White House and met President Obama. That was a very proud moment. On a day to

		day basis my proudest moments are with my students, especially when I see students who really didn't believe in themselves, and after a few months or a few years of hard work they just rise and fly on their own. That's a tremendous source of pride.
Evelyn Lamb:	16:18	Well I thank you a lot for being on the show here. I've really enjoyed talking with you.
Mariel Vazquez:	16:24	Yeah, I've really enjoyed it, too. Thank you so much.
Recorded Msg:	16:29	Thank you for listening to the Lathisms podcast. It's produced by me, Evelyn Lamb, and made possible by a Tensor SUMMA grant from the Mathematical Association of America. Our music is Volvera by La Floresta. Lathisms is an initiative to celebrate the accomplishments of Hispanic and Latinx mathematicians. It was founded in 2016 by Alexander Diaz-Lopez, Pamela Harris, Alicia Prieto-Langarica, and Gabriel Sosa. You can find more information about the project at Lathisms.org. That's L-A-T-H-I-S-M-S.O-R-G. Join us next time to hear from another inspiring mathematician.