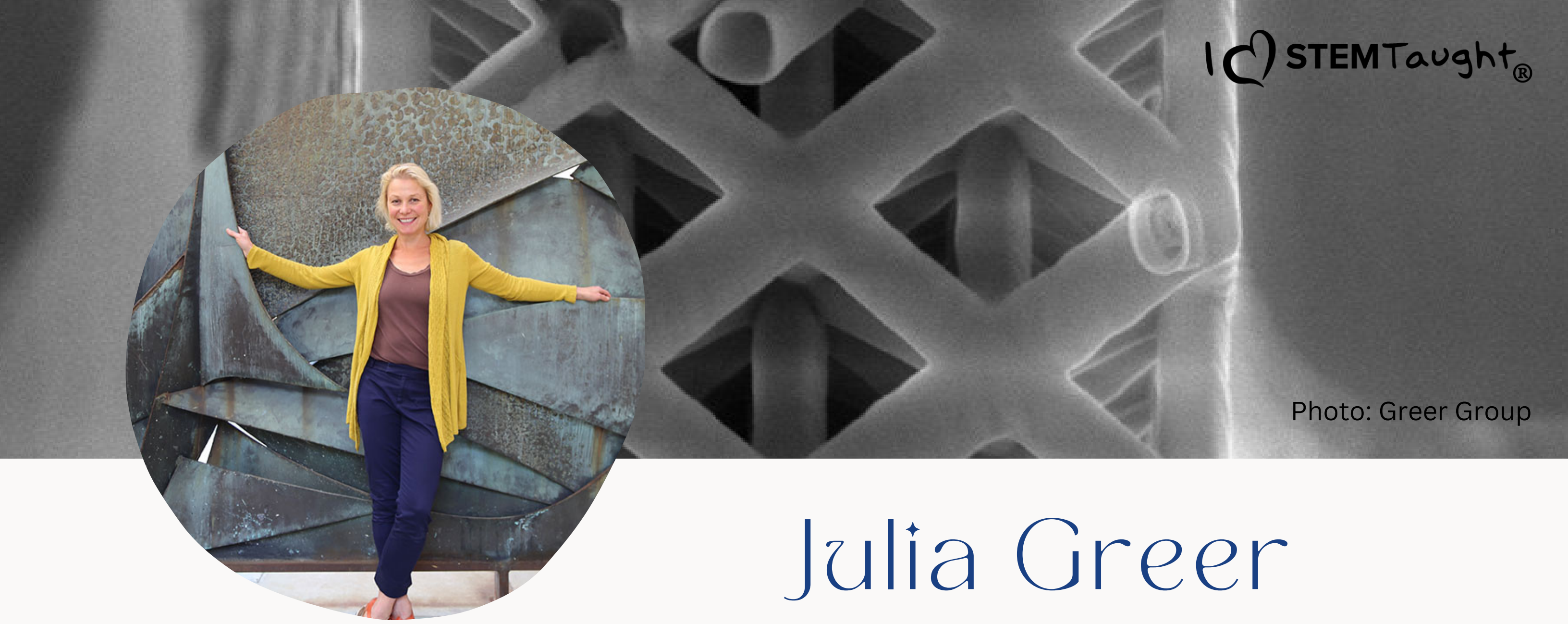

Photo: Greer Group

Julia Greer

Julia has always loved the letter ‘m’. Something about the structure and the shape of the letter, the twin hills, the gentle curves, the way it dips down before rising up again, and the symmetry of the shape always appealed to her.

Little did she know that throughout her life, this single letter of the alphabet would play a profound role. She grew up in **M**oscow—near the **M**oskva River, and became a **m**usician, weaving beautiful tunes with elegant grace on the piano, even today as a concert pianist. Later, she went to **MIT**, studied **m**aterial science, did **m**echanical engineering, and became a **m**other: the mighty little m.

However, Julia’s story begins a bit before this string of achievements with the letter ‘m’. It begins with the letter ‘n’: n for nano, or the extremely, minutely, infinitesimally, more-than-microscopically small.

It begins in a landscape where the Cold War in Russia was just ending, and every day, Julia saw people carrying immense loads. Sometimes, they were things you could see—like materials to rebuild their homes with. At other times, they were things you couldn’t see, but carried in your heart, like memories of her homeland she brought with her to New York when she immigrated to America. They were memories of steaming bowls of Borscht—beet soup—or of playing lapta (like baseball) with her friends. But she never let these things weigh her down, just like she noticed dandelion florets blowing freely while carrying their precious load.

Julia was excellent at math. Although she didn’t speak English when she came to America at the age of 15, she was so gifted at math that she soon learned by teaching her classmates. She gave them numbers; they gave her words. She loved letting the world around her swirl into quiet as she focused on the mathematical problem, a musical composition or studying the materials that make things.

Today, Julia is fascinated both by structures in the natural world and by the ways engineers make structures to be strong and robust—without necessarily being heavy. She loves the great pyramid of Giza, over 400 feet tall (like a 100 young Julias stacked one on top of the other!) and weighing as much as six giant airplanes. But as she read, played music, discovered and explored the world around her, she noticed that engineered structures, like the Eiffel Tower, were twice as tall and weighed a thousand times less.

“Things don’t have to be so heavy if you’re careful about the way you engineer them,” she always says.

As she kept exploring materials around her, she realized that at the nano scale, a lattice like structure—like a fishing net or a pretty trellis in the garden—made materials extra strong. It was like being an architect in reverse. Instead of using the tightly interwoven structure to make a building, Julia makes materials stronger and more resilient. “Smaller can be stronger,” she says. Even if the insides are hollow straws, the structure of the material makes it stronger to build with at a molecular or microscopic level!

That’s because at the teensiest, tiniest, one-thousandth of the width of one strand of hair level, materials behave differently than they do at a large scale.

During her lab work, Julia discovered that diatoms, which are unicellular algae, have a protective shell light enough to prevent them from sinking, but strong enough to protect them from predators. Julia’s research shows that the lightweight structure of the diatom shell is stronger than anything else!
Using her understanding of the strength of smallness, she designs materials that are arranged in a way at a nano scale to be massively strong yet lightweight. She hopes to make armour that soldiers can wear even when it’s hot, but will protect them against danger. In the future, she wants to make a shirt where the material will just reconfigure or arrange itself based on sensing the weather—you could wear the same thing in Alaska or Hawaii, without even having to change! When the temperature is cold, the material will rearrange itself to be tightly woven and offer protection against icy winds. But when it’s hot, it would automatically become more porous to help you enjoy a walk on the sunny beach. Such inventions and science may take some time, but if we keep believing in the strength or smallness and learning from things like diatoms, it may happen sooner than we think.

For now though, grown-up Julia loves to whizz through the world on her rollerblades while dreaming of her next scientific adventure: the problems she’ll try to solve, the tiny structures she’ll celebrate, and the new questions she’ll ask to create the most wonderful ‘m’ in science: magic.