# The Truly Spooky Powers of Spider Silk

Spider webs are everywhere in ghoulish Halloween decorations, but they deserve to be celebrated as a model of natural engineering


Illustration: Tomasz Walenta


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*Physicist Helen Czerski explores the complex science behind familiar phenomena. Read more columns here.*

Halloween is nearly here, and the familiar ghoulish imagery has been slinking into stores and homes for the past few weeks: witches, black cats, skeletons and bats. They’re chosen to inspire fear and revulsion—mysterious creatures that lurk in the dark and are clearly up to no good.

But one member of this group in particular—the humble spider with its web—is done a great disservice by these witchy associations. Spider silk is one of the most extraordinary materials on Earth, and any spider that can weave it (which is all of them) surely deserves our admiration and awe, not horror.

A spider is a walking factory, capable of producing up to seven different types of silk. From the spinneret glands in their abdomen they can pull forth the raw material to make webs, nests, cocoons or alarm lines, to wrap up prey or to suspend themselves from the ceiling. Consider a human-made factory for materials: a maze of belching furnaces, potentially toxic ingredients, fumes and protective equipment. By comparison, in a fraction of a second, a spider can make a material that is stronger than steel for its weight and also fabulously stretchy, biodegradable, and edible (some spiders eat their used silk to recycle it). How do they do it?

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The strength of spider silk comes partly from the long proteins that it’s made from and partly from the way that they’re arranged as the silk emerges from the spider. The proteins are formed and then stored in a sac in the form of liquid globules surrounded by water. As the spider uses its legs to pull silk out of a spinneret, these globules are squeezed into a narrow tube. As they progress along the tube, the water is removed and the acidity increases. The physical shearing forces and the chemical changes start to organize the proteins, and as they emerge, the last of the water evaporates, and the proteins solidify into silk. The exact protein arrangement determines how strong and stretchy the silk is, and spiders will use different types of silk for different parts of their web.

Spider silk is less than one thousandth of an inch in diameter, but inside that slender strand there is a bundle of protein fibers within a protective shell. Some of the proteins are folded up into rigid crystals just a few nanometers across, which provide strength, and these crystals sit inside a more jumbled-up matrix of the other proteins. This matrix gives some spider silk the ability to stretch to five times its original length without breaking, as protein spirals stretch out while holding the crystals in place.

The strength and flexibility is amazing enough, but there’s yet another trick hidden in this structure. When spider silk gets wet—for example, when dew covers it—the proteins become rubbery and then get wider and shorter. This has the effect of tensioning the silk, like turning a key to tune a guitar string. So a spider web will start the morning bouncy and taut, freshened up by nature overnight. Human scientists would love to make artificial spider silk, to use it in medicine and manufacturing, but currently no-one can copy the amazing subtlety of what spiders do every day.

Cobwebs are just leftover spider webs, natural protein sculptures that have outlasted their usefulness to the spider. It’s not especially nice to walk into one on a dark night, but the fact that such delicate and strong structures exist is amazing. So next time you see a Halloween spiderweb, spare a thought for the real spiders out there in the world, creating beautiful silk with phenomenal material properties, hiding in the dark—and watching you with all eight eyes.

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