NATURE'S LABORATORY

" *Friends tie their purses with a spider's web.*"
-- Proverb

Especially after a heavy storm, the wayward strands of a cobweb swinging in the breeze seem flimsy things. But consider for a moment that those silk threads have enough strength and elasticity to outperform Kevlar (the component fiber in bulletproof vests), and are able to withstand an impact five times more powerful. None other than the spider weaves such a web, an architectural marvel in and of itself.

Although most people lump spiders in with flies and other bugs, spiders aren't insects. Spiders and their fellow scorpions, whip-scorpions, whip-spiders, harvestmen, ticks and mites, are arachnids. Arachnids and insects are both arthropods, belonging to the phylum *Arthropoda*. Spiders are distinguished not only by their appearance -- eight legs, a two-segmented body, and no antennae -- but by their craft: spiders can spin silk thread and can make webs.

Spider webs can serve several purposes, including shelter and a means to catch prey. The silk itself can be woven into a traditional web, cast as a net, dangled like fishing line, or used to bundle and protect eggs. While all spiders can produce silk, not all use webs to catch their meal -- some simply rely on stealth.

Some species have as many as seven different silk glands. Each gland manufactures a silk with different properties of elasticity, strength, and stickiness. Each strand of silk can be made up of finer threads as small as 1/1,000,000 of an inch in diameter.

Spider silk is actually a liquid protein squeezed out of spinnerets, which guide and manipulate the silk as it emerges. As the spider tugs on the emerging silk, the silk hardens and strengthens. The resulting silk is strong enough to withstand a struggling insect, yet elastic enough to stretch twice its length without breaking.

Spiders can weave webs in any number of shapes: funnels, domes, sheets, scaffolds. The classic spider web, immortalized in E.B. White's "Charlotte's Web," is the orb web. Made, for example, by common garden spiders, orb webs look like the spokes in a bike wheel, wound about with an inward-spiraling thread. And that is exactly how they are built.

First, a spider releases a single strand of dry silk into the air. After it catches on a surface, the spider ties off this primary support line, then reinforces it. A second thread is strung below and parallel to the first, from which the spider fastens a third thread at its midpoint. This third thread is tied off below, so that the framework resembles a lidded "Y". Off of these initial hub threads, addition spokes are spun, radiating from the fork of the "Y".

Once the spokes are in place, a temporary spiral of dry silk is pin-wheeled outward to reinforce the spokes. Lastly, sticky silk is laced between the spiraled threads. As the spider works its way inward, it eats the temporary spiral's silk to recycle the essential proteins, in turn setting each permanent sticky thread by snapping it into place. The "snap" breaks the silk's sticky coating into beads, setting the trap.

Another example of web design is the seemingly haphazard scaffold web, from which dangle streamers of silk weighted with droplets of glue. When an insect stumble into the gluey end, the elastic strand breaks and yanks the bug skyward. There, the insect is easy prey for the awaiting spider. Web-building spiders don't stick to their own webs because their feet sport specially designed hairs and oils that keep them from sticking.

Since their vision can be poor, spiders instead rely on vibrations to detect prey. By keeping a leg attuned to a spoke thread, or "telegraph line," the spider can almost immediately determine the size and location of any intruder or potential meal. Up to 95 percent of insects that bumble into the web will find themselves ensnared. Dinner is served.

Not only is spider's silk strong, it also repels water and bacteria. Scientists hope to one day apply its properties to the everyday world: air bags, fishing line, car bumpers, surgical sutures, clothing, even artificial tendons. Unfortunately, spiders are hard to farm since, in any considerable number, they tend to eat each other. Instead, scientists are turning to biomimicry, copying nature, to artificially manufacture spider silk in the laboratory.

So far, researchers have manufactured spider silk genes and some preliminary fibers, but they're not half as strong as true spider silk. Even if we unlock the spider's secret, there will always be something magical in their ephemeral webs.

***Hands On**:* Since pollen and dust can gunk up the sticky silk, and errant bugs can leave webs in tatters, spiders can rebuild their webs as often as two times a day, sometimes in the same spot. To watch a spider build a web from scratch, head into the backyard in the

early morning. If you situate yourself just right and take care not to disturb the spider, you can watch the weaver at work

If you aren't lucky enough to catch one in the act, look instead for a spider mending its web in midday. Also keep an eye out for webs on especially dewy mornings. Moisture, even hoar frost, can collect on the strands to create a bejeweled tapestry in the early morning sun. Spiders will sometimes drink the dew that catches in their webs.

Matthew Bettelheim graduated from the University of California, San Diego, with a Bachelor's in Science, and is at present a practicing freelance science writer.