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UCSB Scientists Answer K-12 Science Questions Via Internet

How strong is spider silk? A third grade student, inspired by having read "Charlotte's Web," recently posed this question to several scientists at the University of California, Santa Barbara, thanks to an innovative Internet education program. The answers that scientists gave display several different research perspectives. (A sample of their responses appears later in this release.)

ScienceLine, which is sponsored by the Materials Research Laboratory (MRL) at UCSB and aims to link local schools in the tri-county area with university scientists, recently announced its newly expanded web site (www.scienceline.ucsb.edu). The site has already posted over 400 questions and answers in the areas of life, earth and physical science, a tribute to the commitment and interest of over 100 UCSB faculty members, as well as post-doctoral and graduate students.

Fiona Goodchild, education director for the Materials Research Laboratory (MRL), recently presented an analysis of the program at the national meeting of the American Association for the Advancement of Science.

"ScienceLine encourages students to be curious about scientific phenomena and to formulate their own questions about their understanding, or lack of it," said Goodchild.

"Scientists enjoy the challenge of answering questions in a way that makes sense to the novice learner. Teachers find it valuable to see how scientists from different disciplines answer the same question. ScienceLine also links science and technology in a way that emphasizes the important role of technology in scientific investigation."

Schoolteachers praise the program. For example, John Rucker, chair of the Science Department at Righetti High School said, "High school students are very curious and can ask amazing questions, just not always at the right time. With ScienceLine, students finally have a place to get the good questions answered by field professionals."

Kathy Foltz, a professor of biology at UCSB, stated, "I firmly believe that if young people are encouraged to ask questions and have access to scientists, they will be motivated to consider the sciences as a career option and be lifelong questioners."

Since September, UCSB scientists have responded to more than 90 questions, reflecting increasing traffic on the new web site. This year Martina Michenfelder, the moderator, is also expanding its activities to include video conferencing between science classes at a distance from campus and UCSB scientists. Many of these classes are at UCSB Partner Schools that are currently introducing students to using the Internet as a research tool. Michenfelder encourages teachers to contact her about how ScienceLine can enrich their classroom activities by going to the web site where contact information is posted.

ScienceLine is supported by the National Science Foundation, the Materials Research Laboratory, and the UC Santa Barbara School-University Partnerships.

So what did the scientists say in response to the question about spider silk, or as the third grader put it, "What is the spider silk made of and how can it be so strong as to hold a spider?"

Using ScienceLine, the program that links kindergarten through 12th grade students with scientists at the UCSB, the student received many answers including the following parts of answers from a few different scientists:

Answer 1: Good question about spider silk. Scientists are very interested in spider silk because it is stronger than steel. It's true! If you made a steel string as thick as a spider's string, the spider string is stronger. That is amazing, isn't it!

Scientists have studied spider silk and they know that it is extremely strong. They also know that spider silk is made out of protein. Do you know what protein is? I'll give you a hint, and then maybe you can look it up in the dictionary or an encyclopedia. Protein is the stuff you get from eating meat or beans. It's found in all living things. It is what your muscles are mostly made of.

Think about that for a second. That means that spiders have used proteins to make a string that is stronger than steel. Isn't that incredible! Spiders need to have a strong string because they use the string (called spider silk) for many different things. They use it for constructing their webs, making egg sacs, wrapping up their prey, as a life line when jumping, or dropping to escape, and as a shelter in which it can retreat.

Did you know that spiders can easily recycle their silk? They can eat their old web and use the protein to make a new one. Wow!

Answer 2: Spider threads contain many long molecules called proteins. These proteins are aligned along the thread and all work together to hold up the spider. In part, spider thread is strong because there are so many proteins all lined up together. However, that's not the whole story. Each protein in the spider's thread is a spring which can be stretched a long way before it breaks. The result is that it takes a lot of force to stretch a spider's thread, and you have to apply that force over a long distance before it will break. When you apply a force over a distance, physicists say you have done "work." It takes a lot of work to break a spider's thread.

Answer 3: Spider silk is made of several kinds of proteins. These proteins are processed and stored within the spider's abdomen. Spiders typically have six or eight spinnerets, organs at the rear of their abdomen, through which they extrude the silk proteins. During the process of extrusion, the proteins are lined up in a way that locks them into place and makes them very hard to separate. The process of extrusion is under intensive research because very little is known about it. In fact, spider silk is so strong that it is believed to be the strongest known substance for its weight. Believe it or not, the U.S. military has invested a great deal of money into researching the physical properties of silk and how it is made!

Answer 4: Spiders make many kinds of silk. The best known is dragline silk which the spider uses in web construction and also for "hanging around." Dragline silk consists

of proteins called spidroins. These are made in the spider's silk glands as a thick paste that is drawn into fibers during spinning. Once spun, the silk is strong and very tough. It not only supports the spider but can trap a very large beetle.

Scientists estimate that if dragline silk could be faithfully reproduced with the thickness of a pencil, it would be strong enough to stop a large jet plane in flight.

There are many theories about what makes dragline silk so strong, but no certain answers at this time. Most scientists agree that the strength is related to the spinning process which appears to crystallize parts of the spidroins.

About UC Santa Barbara

The University of California, Santa Barbara is a leading research institution that also provides a comprehensive liberal arts learning experience. Our academic community of faculty, students, and staff is characterized by a culture of interdisciplinary collaboration that is responsive to the needs of our multicultural and global society. All of this takes place within a living and learning environment like no other, as we draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.