SCIENTISTS IN THE FIELD

WHERE SCIENCE MEETS ADVENTURE

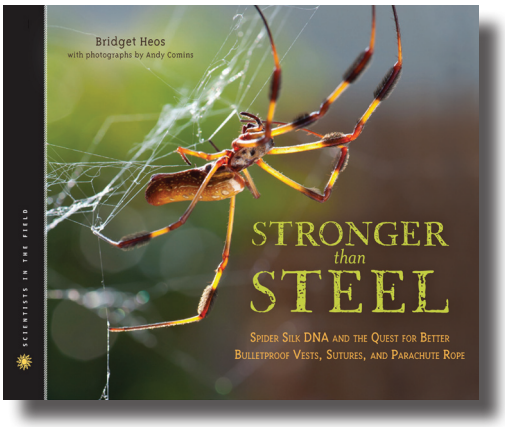
DISCUSSION AND ACTIVITY GUIDE

Stronger Than Steel: Spider Silk DNA and the Quest for Better Bulletproof Vests, Sutures, and Parachute Rope

by Bridget Heos Photographs by Andy Comins

About the Series

Stronger Than Steel is part of the award-winning Scientists in the Field series, which began in 1999. This distinguished and innovative series examines the work of real-life scientists doing actual research. Young readers discover what it is like to be a working scientist, investigate an intriguing research project in action and gain a wealth of knowledge about fascinating scientific topics. Outstanding writing and stellar photography are features of every book in the series. Reading levels vary, but the books will interest a wide range of readers.



Stronger Than Steel:
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by Bridget Heos

About the Book

What do goats, alfalfa, and silkworms have in common? Spiders! Spider silk is universally acknowledged as one of the toughest and strongest materials on the planet. Farming spiders, however, has not been successful. They do not play nicely together. They tend to eat each other. They are also small, and extracting enough spider silk to make a bulletproof vest is not practical. So Dr. Randy Lewis is exploring methods for the transfer of spider genes to goats, alfalfa, and silkworms. Transferring spider genes to other organisms, creates transgenic organisms—life forms with genes from another organism inserted—something that is extremely controversial. *Stronger Than Silk* examines the work that Dr. Lewis and others are doing and weighs the ethical concerns against the benefits that people could reap. Scientists hope to discover a method for harvesting vast quantities of spider silk, which is strong enough to stop a 747 airplane if woven into a rope with a one-inch diameter. In addition to plane-stopping ropes and bulletproof vests, spider silk could be used for sutures in surgery, to repair ligaments, or as parachute ropes, and much more. Discovering how spiders can be connected with goats, alfalfa, and silkworms shows students that scientific inquiry is every bit as creative as any other human venture.

About the Author

Bridget Heos has written more than forty books for young readers. She lives in Kansas City with her three sons and loves sharing books with others. Her advice for hopeful writers is to read as many children's books as possible!

About the Photographer

Andy Comins is a California-based photographer dedicated to bringing the wide world of scientific knowledge to children of all ages. This is his second collaboration on a Scientists in the Field title.

Houghton Mifflin Harcourt Books for Young Readers
Visit www.sciencemeetsadventure.com for authors' Adventure Notes, teacher resources, videos, and more!

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Pre-Reading Activity:

Show a trailer from a Spider-Man movie (or a snippet from a DVD) that shows Peter Parker swinging from spider silk or stopping a plane with spider silk. Pass around a bit of an actual spider web (preferably NOT from an active outdoor web). Talk to the students about fiction and nonfiction. Ask students about whether the movie depiction of spider silk is realistic. Then read to the students the text from page 8 about the actual strength of spider silk. How can spider silk be so strong when we can pull a web apart with our hands?

Show pictures of jackalopes and other folkloric animals that combine various animals into one organism. Show pictures of donkeys and ligers and other genetic mash-ups. Ask students what would happen if we combined spiders with other types of animals, goats for example.

Discussion Questions:

Currently transgenic goats may not be sold and may not be eaten. When researchers need to remove these goats, they must kill them and dispose of them. Does the law need to be changed as Dr. Lewis suggests, or does the law protect us from potential unknown effects from consuming transgenic organisms? Are transgenic organisms in general an ethical use of these life forms?

Dr. Lewis is exploring gene transfers from spiders into goats, alfalfa, and silkworms. Why these three organisms?

Spider silk is incredibly strong! This fact forms the basis of the Spider-Man cartoons and movies. Think about other animals or plants and their special traits. What new animal or plant will form the basis of our next movie or cartoon superhero?

Applying and Extending Our Knowledge:

Spiders spin six or seven different types of silk that differ in how tough they are. We learn from the book that "toughness" is an actual measurement. How hard is it to fracture the material? Spider silk also needs to be elastic or, in other words, stretchy.

- Find the toughness of a paper towel, a tissue, and toilet paper (use the same brand for all students). Using a small plastic bowl, marbles (same size and weight), and rubber bands large enough to hold the paper over the bowl, drop marbles onto the paper from two feet above. Did any of the paper rip? Repeat from different heights. What is the relative toughness of the papers tested? Repeat with different brands or heavier marbles, etc.

Common Core Connection

RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

- If the spider silk is too hard and tough, insects that fly into the web will just bounce off. Teachers can demonstrate this by dropping a marble into a metal colander and dropping a marble into a mesh net. If a web is not tough enough, the insects will just fly through. Design a web or a portion of a web using different color string to represent the different types of silk. Label the string so we know which is tougher and which is more elastic. Write a justification for your reasons for choosing the threads you did. Make sure to indicate which silk needs more toughness and which needs to stretch more. Explain why your web will catch insects and not be ripped from its tree or location. Design a spider egg sack. Use six different string colors to design a chart showing the different kinds of spider silk. Explain its function. Put in order from the toughest to the least tough.

Common Core Connection

RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

RH.6-8.7. Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.

- Watch Cheryl Hiyashi's fifteen minute TED talk about the magnificence of spider silk: www.ted.com/talks/cheryl_hayashi_the_magnificence_of_spider_silk.html.

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- Compare the World Wide Web with a spider web. Create a Venn diagram comparing them with at least five differences and similarities.

Common Core Connection

RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Additional Print Resources

Allman, Toney. *From Spider Webs to Man-Man Silk*. Kidhaven, 2005.

Tagliaferro, Linda. *Genetic Engineering: Modern Progress or Future Peril? Twenty-First Century Books, 2010.*

Web Resources to Explore

Worldwide Spider Webs
www.conservation.state.mo.us/conmag/1996/decoi/1.html

This project is designed to acquaint second and third grade students with spider webs. Students will use selected Internet sites to answer questions about the construction, variety, and use of the webs. A list of useful websites.

Arachno Web:

www.arachnology.org
Website of the International Society of Aracnology.
Provides a list of websites, some for kids, on identification, information, and resources on spiders and webs.

You and Your Genes
kids.niehs.nih.gov/stories/genes/genes05.htm
Information on genes from the National Institute of Environmental Health Sciences

Genomics – Actionbioscience.org
www.actionbioscience.org/genomic
Site from the American Institute of Biological Sciences provides links to articles on genomics information and ethical discussions.

Guide created by:
Ed Spicer, Curriculum Consultant, and Lynn Rutan, retired middle school librarian, now reviewer and blogger at Bookends: the Booklist Youth Blog