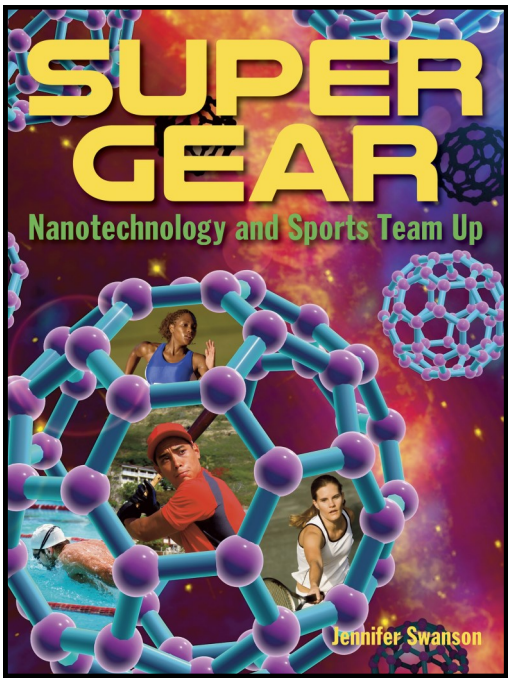
Discussion points, activities, and writing prompts to help educators use
Super Gear: Nanotechnology and Sports Team Up
as a classroom read aloud or as a selection for independent reading.
Great for book clubs, too!

About the Book

What do Usain Bolt, Serena Williams, and Michael Phelps have in common? These super star athletes all rely on equipment enhanced with nanotechnology. Nanotech engineers are creating microscopic particles that behave like nothing we've seen before. They can move these particles around to invent all-new materials and develop high-performance gear.

Nanotechnology makes track shoes and tennis rackets stronger and lighter. It produces swimsuits that slice through the water faster and golf clubs that hit the ball farther. In fact, nanotech gear is found in almost every sport played today.

Nanotechnology is cutting-edge science that is changing the world of sports as we know it. Will it help you stay ahead of the game?



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Aligned to the Common Core & Next Generation Science Standards Grades 4–7

About the Author

Jennifer Swanson is a middle school science instructor for Johns Hopkins University's Center for Talented Youth, as well as the award-winning author of more than twenty nonfiction and fiction books for children. Her books include *Brain Games: The Mind-Blowing Science of Your Amazing Brain* and *The Wonderful World of Wearable Devices.*

Jennifer loves science and engineering—and sports, too. She enjoys swimming, biking, and watching football. When the Olympics are on, her family puts on Team USA gear and analyzes the play-by-play action. Jennifer and her athletic and scientific family live in Jacksonville, Florida. Visit her at www.jenniferswansonbooks.com.

This guide was created by Marcie Colleen, a former teacher with a BA in English Education from Oswego State and MA in Educational Theater from NYU. Marcie can often be found writing picture books at home in Brooklyn, New York. Visit her at www.thisismarciecolleen.com.

Common Core Alignment for Grades 4–7

Grade 4: ELA. RI.4.1-4, 7-9; W.4.1, 2, 4, 6-9; SL.4.1-4; L.4.4;

Grade 5: ELA. RI.5.1-4, 7-9; W.5.1, 2, 4, 6-9; SL.5.1-5; L.5.4;

Grade 6: ELA. RI.6.1-8; W.6.1-2, 4, 6, 9; SL.6.1-5; L.6.4; RST.6-8.1-3, 7, 9; WHST.6-8.7, 8, 9

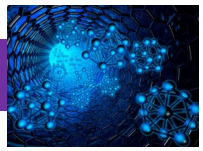
Grade 7: ELA. RI.7.1-6, 8; W.7.1-2, 4, 6, 7, 8; SL.7.1-5; L.7.4; RST.6-8.1-3, 7, 9; WHST.6-8.7, 8, 9

Next Generation Science Standards Alignment for Grades 4–7

Grades 4 and 5: 3-5-ETS1-1, 3-5-ETS1-2, 3-5-ETS1-3; 5-PS1-1, 5-PS1-2, 5-PS1-3; 4-PS3-1

Grades 6 and 7: MS-PS3-1; MS-ETS1-1, MS-ETS1-2, MS-ETS1-3

Introduction



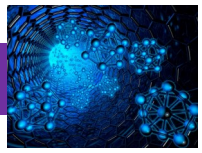
1. Define the following terms in your own words, using the text for reference.

- Nanotechnology
- Nanoscale
- Nanoparticle
- Nanometer

2. Imagine that you are a professional athlete who has read the introduction to *Super Gear*. Write a letter to a scientist describing what you have read about nanotechnology and asking for help in creating better performing clothing and/or equipment.

3. Using a ruler or tape measure, measure the length of your hand from the tip of your middle finger to the base of your palm in centimeters and inches. If 25,000,000 nanometers equal 1 inch, or 2.54 centimeters, can you convert the measurement of your hand to nanometers?

Chapter 1: Tiny Bits of Science



1. Using a handful of LEGOs, make models of the following:

a. An atom

b. A molecule

c. Liquid water

d. Ice

2. What is the difference between graphite and diamond? How is graphite used at the nanoscale? Why?

3. On page 6, the author writes, “Particles at the nanoscale don’t follow the same rules of science that the rest of us do.” How are nanoparticles unique in terms of:

a. Strength?

b. Color?

c. Gravity’s effect on them?

d. Surface area?

4. Conduct an Internet search to find images or videos of the following. Share what you find with the class.

a. Scanning tunneling microscope (STM)

b. Optical nanotweezer

5. What is meant by “engineering from the top down”? Provide an example to illustrate your definition.

6. Why is nanotechnology considered “engineering from the bottom up”?

7. Based on what you have read about nanotechnology, do you think the mass-produced sports equipment you buy in the store will have the exact same nanotechnology qualities as those individually created for professional and Olympic athletes? Why or why not?

Science in Action! Surface-Area Solutions

Try this experiment to see how surface area affects the behavior of a substance.

Materials

2 glass cups

2 cups (470 milliliters) of very hot water

3 cups (600 grams) of granulated sugar

3 cups (380 grams) of powdered sugar (confectioners’ sugar)

2 pieces of thin cotton string (about double the cup’s height in length)

2 paper plates

2 pencils or wooden sticks

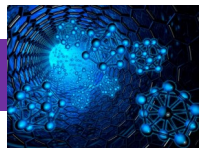
2 washers or other weights

Procedure:

1. Label one cup “granulated sugar” and one cup “powdered sugar.”
2. Pour 1 cup (235 milliliters) of very hot water into each cup.
3. Pour the granulated sugar into one cup and the powdered sugar into the other cup. Stir until the sugar has dissolved. Note how long it took for each type of sugar to dissolve.
4. Put one string in each cup. Allow the strings to soak for about 5 minutes. Take them out and place them on separate paper plates.
5. Allow the strings to dry for about 10 minutes. Then take each string and tie one end to the middle of a pencil. Tie a washer to the other end.
6. Place each pencil across the top of a cup, so the string and washer hang down into the sugar solution.
7. Leave the strings in the solution for 4 to 7 days. Watch as crystals form on the strings. Then take the crystals out and look at them with a microscope or magnifying glass.

Ask yourself:
Which sugar had more surface area? Did that sugar dissolve faster? Why? How are the crystals grown from the two types of sugar different?

Chapter 2: Super Suits



1. What is drag?

   a. Identify three examples of drag.

   b. Name three ways that athletes combat drag.

2. Knowing what you know about drag and turbulence, find images of the following and identify which you think will fly or swim faster. Explain your choices.

   a. Commercial airplane and military fighter jet

   b. Shark and puffer fish

3. Taking into consideration drag and turbulence, create a paper airplane that can fly fast and far. Have a contest with your classmates. Whose plane is the fastest? Whose plane flies the farthest? Can you determine why?

4. Describe Under Armour's Mach 39 speed-skating suit and how it was designed to decrease both turbulence and drag.

5. Speedo's LZR Racer swimsuit was designed with NASA's input. Conduct further research on the Internet and create a multimedia presentation regarding:

   a. The design and development of the suit

   b. The suit's compression effect

   c. The effect of the suit on the 2008 Summer Olympics

   d. Controversy and changes in competition rules

6. Imagine that you are a superhero. Design your own super suit using what you have learned about nano-technology.

Science in Action! Feel the Drag

Want to see exactly how drag affects a swimmer in the water? Give this experiment a try:

Materials:

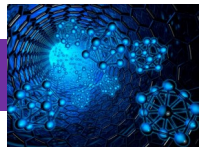
Plastic plate	Basketball
Baseball	The wing from a toy plane, or big curved spoon (The object must have a curve to it like an airplane wing.)

Procedure:

1. Fill up your bathtub halfway with water.
2. Starting from one end of the tub, push each object through the water. Push the objects in a straight line and at the same approximate speed. How hard do you have to push on each object?
3. Look at each object as you push it. Does the water in front of the object ripple? How about behind the object?

Ask yourself:
Which object was the most difficult to push through the water? Which object experienced the most drag?

Chapter 3: Super Bats, Rackets, and Clubs



1. What are the three qualities that determine a “good” baseball bat?

2. Explain the concept of carbon nanotubes.

3. In your own words, explain how carbon nanotubes are incorporated into nanocomposite baseball bats.

4. Why does Major League Baseball not allow its professional players to use nanotech bats? Do you agree with that decision? Why or why not? Use Chapter 3 as textual evidence.

5. What is graphene and how is it used to create better performing tennis rackets?

6. How is nanotechnology used to improve golf clubs?

7. Nanotechnology has been used in golf and tennis balls. Explain how and to what result.

Science in Action! Find the Sweet Spot

Want to find the sweet spot of your baseball bat? Get a friend and try this experiment.

Materials:

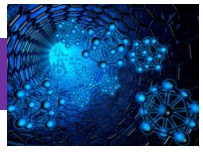
Baseball bat
Hammer

Procedure:

1. Hold the bat in one hand so that the barrel hangs down toward the ground.
2. Have your friend tap lightly on the bat with the hammer, starting at the bottom of the bat. As the bat is struck, you should feel your fingers tingling.
3. Have your friend slowly move up the bat, tapping as he or she goes. When the tapping does not cause a tingling sensation in your fingers, you’ve found the sweet spot of the bat.

Ask yourself:
Why is the sweet spot the best place to hit the ball? Is it just because that’s the part that makes your fingers tingle less? Try this experiment with different types of bats to see how weight, length, and material affect the location of the sweet spot.

Chapter 4: Super Shoes



1. Match the following qualities of a good running shoe with the nanotechnology that improves each function. Then further explain in your own words.

Comfort	Nanoplates
Light weight	Nanopolymers
Shock absorption	Nanofibers

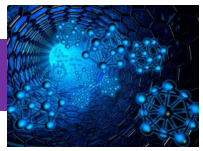
2. Conduct an Internet search for brands of running and racing shoes.

   a. What are some of the descriptive words used to market these shoes?

   b. Identify any words or phrases in the descriptions that might be referring to nanotechnology.

   c. Rewrite one description to include nanotechnology.

Chapter 3: Super Bats, Rackets, and Clubs



1. List at least three ways nanotechnology is being used in sports equipment and clothing, as mentioned in Chapter 5.
2. Choose a popular sports item not mentioned in *Super Gear* and brainstorm how to redesign it with nanotechnology to improve its performance.
3. There has been lots of controversy regarding American football and concussion risk. Nanotechnology and "smart helmets" are being used to help address this concern. Conduct Internet research to write a report on concussion, brain damage, helmets, and the high school athlete. Cite at least five sources, including a variety of statistics, news articles, interviews, and individual case studies. Present your report to the class.
4. How is nanotechnology being used to increase safety in sports?
5. Do you think nanotechnology in sports is fair? How do you feel about "technology doping"? Write an opinion essay, using textual evidence from *Super Gear*, as well as other research as necessary.