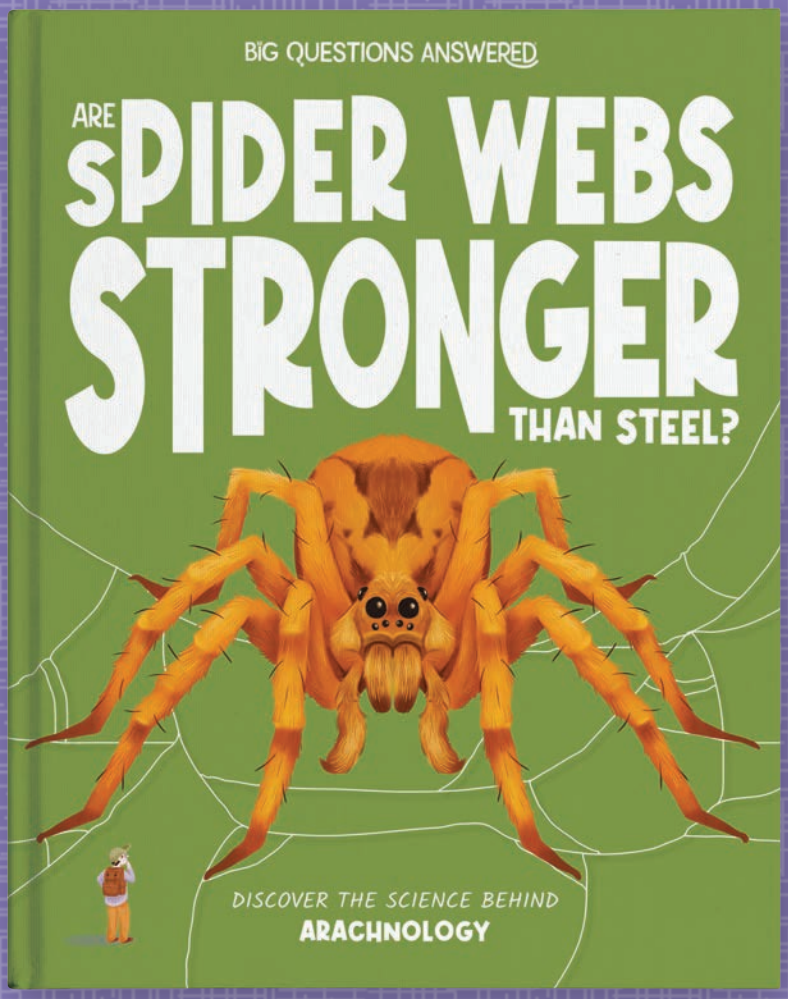
BIG QUESTIONS ANSWERED

TEACHERS' & PARENTS' RESOURCES



Full of thought-provoking questions and fascinating extra information to accompany this book!

CONTENTS:

INTRODUCTION

NOTES FOR TEACHERS, HOME EDUCATORS AND PARENTS

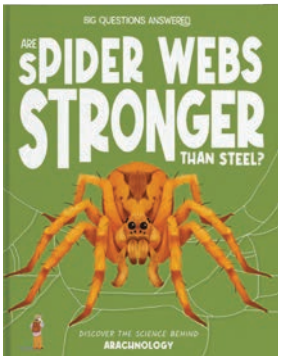
Inspire children's natural curiosity, improve literacy, and have fun learning about different sciences with The Big Questions Answered. Each book in the series is accompanied by a selection of fantastic, **FREE** downloadable resources.

Our **Teachers' and Parents' Resources** booklets are full of ideas for discussions, extra facts, and links to hands-on activities – all great ways to help children explore each field of science and the key topics surrounding them.

Our **Young Scientists' Activity Packs** are a real bonus. They're full of soft-learning, fun activities, all subtly linked to the field of science, that will encourage independent learning. Visit the 'Kids' Zone' to find out more.

Don't forget, on the website you can also download our **'Meet the Scientist' pages** – there's one to accompany each book – and sign up to our newsletter to follow what's coming up next for The Big Questions Answered. Download all these and more at: **www.thebigquestionsanswered.com**

Are Spider Webs Stronger Than Steel? book



Young Arachnologists' Activity Pack

KEY CURRICULUM TOPICS

The resources related to *'Are Spider Webs Stronger Than Steel?'* tie in with key curriculum topics including:

- Animals, including humans
- Everyday materials
- Living things and their habitats
- Uses of everyday materials
- Working scientifically

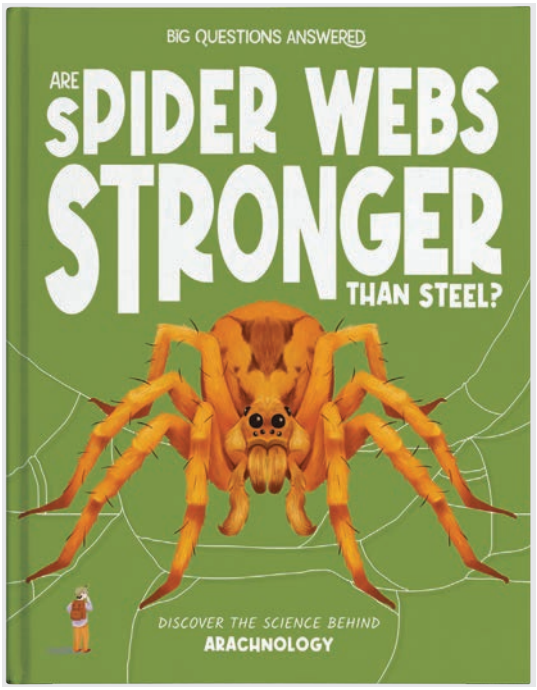
The most relevant topics are indicated throughout this guide.

ARE SPIDER WEBS STRONGER THAN STEEL?

This book explores the extraordinary world of spiders. As well as covering what spiders are and where they're found, this book explores how spiders interact with the world around them, and the power and qualities of the silk they produce. With natural themes, this book also delves into the scientific developments surrounding spider silk that will enhance key sectors, such as construction and medicine.

PRE-READING QUESTIONS

Engage in discussion about the general topic of arachnology with the suggested questions below.



- What do you know about spiders already?
- Do you think spiders are interesting animals? Do you like them? Why or why not?
- Do you think it's possible for spider webs to be stronger than steel? Why or why not?

THE SPECTACULAR WORLD OF SPIDERS: SCENE 1

The material for this scene can be linked to curriculum topics, including:
animals, including humans; living things and their habitats; working scientifically.

Introduce children to the world of spiders with this dramatic opening scene showing a spider climbing across its funnel web. Discuss how many different spiders there are, where their silk comes from, and how scientists study them.

DISCUSSION PROMPTS

- **How many different types of spiders can you name?**

- **How many different types of spiders do you think there are in total in the world?**
Information overleaf

- **How many legs do spiders have? How does this make them different rom insects?**
Information overleaf

- **How do you think scientists study spiders?**

Encourage children to consider factors such as where spiders live, the fact that some are poisonous, and so on. There is also information overleaf.

ACTIVITY

Corresponding activity on page 3 of the activity pack: 'Time for Dinner' is a classic line maze activity, allowing children to interact playfully with a spider trying to find its way to a fly.

THE SPECTACULAR WORLD OF SPIDERS: SCENE 1

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

SPIDERS

A spider is an eight-legged **arachnid,** different from insects due to its two-part body and four pairs of legs. Insects have three-part bodies and three pairs of legs. Scientists have discovered more than 50,000 distinct **species** of arachnid! They often use **venomous** fangs and silk-producing **spinnerets** to hunt **prey**, usually insects.

Spiders are found all over the world, except in Antartica, and live in a wide range of **habitats**, from **tundras** to **tropical** forests. They play an important role in controlling the number of insects living in a particular area.

Scientists study spiders by observing them in their natural habitats or a lab, collecting samples to look at through a microscope, and doing experiments to understand how they learn, hunt, and reproduce.

WOLF SPIDERS

The spider in this scene is commonly called a **wolf spider**. Its scientific name is Lycosidae. They are found in a wide range of **coastal** and **inland** habitats, and although some species have very specific needs, most are wanderers without permanent homes.

This species of spider is known for their incredible hunting skills, pouncing upon prey as they find it or chasing it over short distances. In some cases, they simply wait for passing prey in or near the mouth of a burrow.

PREY

Prey means an animal is hunted and eaten by another animal for food. A good example is a fox hunting a rabbit. The fox is the **predator**, and the rabbit is the prey.

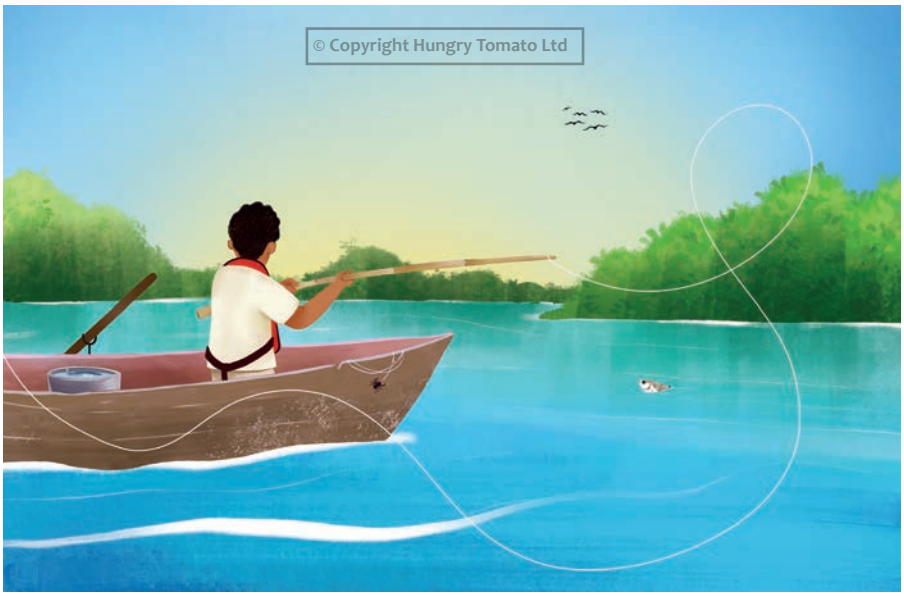
Prey animals are an important part of the **food chain** because they provide food for predators. But predators are also important because they keep the number of prey animals in control. Nature needs balance to keep functioning in a healthy way.

In this context of this opening scene, spiders are the predators, whilst insects like flies are the prey.

ANCIENT USES OF SPIDER SILK: SCENE 2

The material for this scene can be linked to curriculum topics, including:
animals, including humans; everyday materials.

Introduce some of the surprising ways that spider silk has been used in the past and present. Encourage children to think about silk's uses, how it compares to materials we use today, and why scientists are still studying it.



DISCUSSION PROMPTS

- **Why do you think spider silk was useful for fishing or healing wounds?**
Information overleaf

- **How might spider silk be different from materials we use today, like string or bandages?**
Encourage children to think about all the difference physical properties as well as how the materials are created and how long they last.

- **Why do you think scientists are still studying spider silk now?**

- **Can you think of other natural materials people use in clever ways?**

ACTIVITY

Corresponding activity on page 4 of the activity pack: 'Sneaky Spider' is a spot the difference activity where children have to spot 8 differences between two versions of this scene.

Ancient uses of spider silk: Scene 2

Relevant information

Keywords that you may want to pull out and explain have been put into bold.

The usefulness of spider silk

Spider silk has been used by people for thousands of years.

In **ancient** Greece in the **4th century**, doctors applied spider webs to **wounds** to help stop bleeding and keep the cuts clean.

In the Solomon Islands in the South Pacific Ocean, fishermen collected large amounts of silk to twist into fishing lines and nets, which were light but strong enough to catch fish.

These examples show that people recognised the special **qualities** of spider silk long before it was studied by scientists.

In fact, some communities in the world still use spider silk for fishing today! However, this is done on a small scale: it's not a practical solution for catching big quantities of fish as it's not possible to collect lots and lots of silk at once.

Why it works

Spider silk is thin, light, and sticky, but also **flexible** enough to be twisted together without snapping.

When pressed onto skin, it can act like a net to keep a wound closed.

When used for fishing, spider silk's ability to bend without breaking make it effective for catching and pulling fish out of water.

These natural **properties** made it a valuable resource for everyday life in different parts of the world.

THE MEANING OF STRENGTH: SCENE 3

The material for this scene can be linked to curriculum topics, including: animals, including humans; living things and their habitats; working scientifically.

Introduce the idea that 'strength' can mean different things. Discuss how scientists compare strength in terms of lifting, biting, or squeezing and encourage children to think about why different animals might need different kinds of strength.

DISCUSSION PROMPTS

- **What does 'strength' mean in each of these examples?**
  Information overleaf

- **Why might a dung beetle need to push things much heavier than itself?**
  Information overleaf

- **Why do kingsnakes use squeezing strength instead of biting?**
  Information overleaf

- **Can you think of other animals that are strong in unusual ways?**

ACTIVITY

Corresponding activity on page 5 of the activity pack: 'Write Your Own Spider Story' is a creative writing activity which encourages children to write a story about spiders, using three key prompt words.

THE MEANING OF STRENGTH: SCENE 3

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

DUNG BEETLES

Dung beetles (scientific name 'Scarabaeus sacer') are small insects, often only a few centimetres (or inches) long, yet they are able to move objects over 1,000 times their **body weight**! This ability is a combination of **muscle** strength, body shape, and leverage.

They roll balls of dung across the ground to feed themselves and to provide a safe place for their eggs.

SALTWATER CROCODILES

Saltwater crocodiles (scientific name 'Crocodylus porosus') are the largest living **reptiles**, sometimes growing over 6 metres (19.5 feet) long. Their jaws contain up to 68 teeth designed to grip and crush **prey**.

Scientists measure bite strength in **newtons**, and saltwater crocodiles can **exert** over 16,000 newtons — which is enough to break bones. This extreme bite allows them to catch and eat a wide variety of animals, from fish to large **mammals** like deer, cattle, and water buffalo!

KINGSNAKES AND CONSTRICTION

Kingsnakes (scientific name 'Lampropeltis getula') are **non-venomous** snakes found across North America. They use their strong, muscular bodies to coil around prey and squeeze it until it cannot breathe.

Constriction does not involve teeth. Instead, it relies entirely on body strength and technique to subdue prey such as rodents, birds, or other reptiles. They are much more efffective at catching prey by constricting compared to catching or biting them with their teeth. Its an ability which has developed over many years.

CAUGHT IN THE WEB: SCENE 4

The material for this scene can be linked to curriculum topics, including:
animals, including humans; living things and their habitats; working scientifically.

Introduce the idea of tensile strength. Discuss how spider silk uses this property to hold prey tightly, using the visual of the hummingbird in the web to highlight this ability. Encourage children to consider why spiders need silk with this special quality.

DISCUSSION PROMPTS

- **What does 'tensile strength' mean?**
  Information overleaf

- **Can you think of other natural materials that can stretch without breaking?**

- **Why is tensile strength important for spider silk?**
  Information overleaf

ACTIVITY

Corresponding activity on page 6 of the activity pack: 'Incredible Spider Facts' is a mixture of research and creativity. Children choose a spider, research it, fill in the fact file, and draw it. This activity can be printed multiple times to generate a fact booklet!

CAUGHT IN THE WEB: SCENE 4

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

TENSILE STRENGTH

Tensile strength is a measure of how much **pulling force** a material can withstand before it breaks. Materials with high tensile strength can be stretched a long way without snapping.

Spider silk is one of the best natural examples of this property, which makes it ideal for building webs that must resist the struggles of trapped **prey**.

ORB WEAVERS

Orb weavers are spiders that belong to the family Araneidae and are known for spinning the familiar, wheel-shaped webs often seen in gardens and forests.

Their silk is specially **adapted** to **absorb** sudden shocks, like when flying insects crash into them at high speed. The threads stretch and hold, preventing prey from bouncing free.

CATCHING LARGER PREY

Although orb weavers usually catch insects to eat, their webs are sometimes strong enough to trap larger creatures. There are documented cases of small birds, such as hummingbirds (like the bird in the scene), or even bats becoming **entangled**.

In most cases, the spider does not eat the animal, but the example shows how effective the silk is at **restraining** movement.

EYES IN THE SKY: SCENE 5

The material for this scene can be linked to curriculum topics, including:
animals, including humans; living things and their habitats; working scientifically.

Introduce how spiders use silk for more than catching food. Discuss how some species travel by releasing silk threads that act like parachutes. Use the visual to explain how this helps spiders reach new habitats where they can build webs and find food.

DISCUSSION PROMPTS

- **How do you think a spider uses its silk to travel to new places?**
  Information overleaf

- **Why might it be useful for a spider to travel long distances?**
  Information overleaf

- **What might a spider find when it lands in a new place?**

- **Can you think of other animals that travel using the wind?**

ACTIVITY

Corresponding activity on page 7 of the activity pack: 'Spider Bodies' is an activity where children have to label the spider with the corresponding body part.

EYES IN THE SKY: SCENE 5

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

BALLOONING

The behaviour where spiders travel by releasing silk into the air is called **ballooning**.

The spider climbs to a high point, raises its body, and releases thin silk **threads**. Rising **air currents** catch the silk and lift the spider into the sky, carrying it away like a tiny parachute.

SPECIES THAT BALLOON

Ballooning is most common in young spiders, called spiderlings, but some adults also do it. Many orb weavers (in the family Araneidae) and sheet weavers (in the family Linyphiidae) are known for this behaviour.

The spider in the scene that is travelling like this is a trashline orbweaver.

Spiderlings use ballooning to spread out from the place where they hatched, reducing **competition** with siblings for things like food and **mates**.

LONG DISTANCE TRAVEL

Ballooning can carry spiders surprisingly far. Light winds may move them a few metres (or feet), while stronger air currents can carry them across fields, rivers, or even oceans.

Some spiders have been found on remote islands where the only explanation for their arrival is that they ballooned across the sea! This ability helps spiders **colonise** new areas quickly and successfully.

THE BROWN RECLUSE SPIDER: SCENE 6

The material for this scene can be linked to curriculum topics, including:
animals, including humans; living things and their habitats; working scientifically.

Explain how scientists use microscopes to study spider silk and some of the things they've worked out from these studies. Show how most spiders twist strands together, but the brown recluse makes silk with strands side by side.

DISCUSSION PROMPTS

- **How is the brown recluse's silk different from the silk of other spiders?**
  Information overleaf

- **What might be the advantage of adding loops to silk strands?**
  Information overleaf

- **Why do you think spider silk needs to be so strong?**

ACTIVITY

Corresponding activity on page 8 of the activity pack: 'Creepy Crawly Crossword' is a crossword activity where children use clues to name some key words related to spiders. They can then fill in the crossword with the answers.

THE BROWN RECLUSE SPIDER: SCENE 6

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

MICROSCOPIC STRUCTURE OF SILK

Under a **microscope**, spider silk is revealed to be made of many incredibly thin **strands**.

Each strand is finer than a single human hair, yet together they form threads that can hold struggling **prey** and support the spider's body.

By twisting strands together, most spiders make their silk both strong and flexible.

BROWN RECLUSE SPIDER

The brown recluse (scientific name 'Loxosceles reclusa') is a spider **native** to the central and southern United States. Its silk is unusual because the strands are laid out side by side instead of twisted together.

This spider sometimes adds tiny loops to these strands, which appear to increase the silk's ability to **resist** tearing.

Unlike orb weavers, the brown recluse does not build large webs to catch flying insects. Instead, it spins irregular silk retreats where it hides during the day and hunts at night.

The brown recluse mainly eats small prey like insects like flies, crickets, and cockroaches, but in times of extreme food **scarcity** it has been known to eat other brown recluse spiders! Animals who eat others of the same species are referred to as cannibalistic.

These spiders are one of only two **venomous** spiders in North America, the other being the black widow.

PENCIL-THICK SILK: SCENE 7

The material for this scene can be linked to curriculum topics, including: everyday materials and their uses; working scientifically.

Discuss how spider silk's strength depends on its size. Explain the idea that if silk were much thicker, it could hold extremely heavy objects, like a plane, and use the visual to illustrate this concept in a fun, imaginative way.

DISCUSSION PROMPTS

- **What does it mean that strength is 'relative to size'?**
  Information overleaf

- **Why can't scientists actually test holding a plane with spider silk?**
  Information overleaf

- **How does this comparison help us understand the power of spider silk?**
  Information overleaf

- **Can you think of any other examples where size changes how strong something seems?**

ACTIVITY

Corresponding activity on page 9 of the activity pack: 'Web of Words' is a classic word search activity, using lots of great words related to spiders and their webs, to get children familiar with the language of this field of science.

PENCIL-THICK SILK: SCENE 7

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

STRENGTH IS RELATIVE TO SIZE

Spider silk's apparent **delicacy** hides its remarkable strength. Scientists measure this using **tensile strength**, which is the amount of **pulling force** a material can **resist** before breaking, **relative** to its **diameter**.

Because spider silk is so thin, a tiny strand can hold several times the spider's body weight. This demonstrates that a material's strength cannot be judged by its appearance alone; there is a lot more to it than meets the eye.

THEORETICAL SCALING

Scientists often use mathematics to understand how silk would behave if **scaled up**. For example, calculations show that if a single strand of silk were enlarged to the thickness of a pencil, a web could **theoretically** support the weight of an extremely heavy object.

While this is impossible to test practically, these models help researchers study the **properties** of silk and understand why it is so **effective** at small scales.

UNDERSTANDING STRENGTH

Studying spider silk's **properties** in detail allows scientists to compare it with other **natural** and **synthetic** fibers.

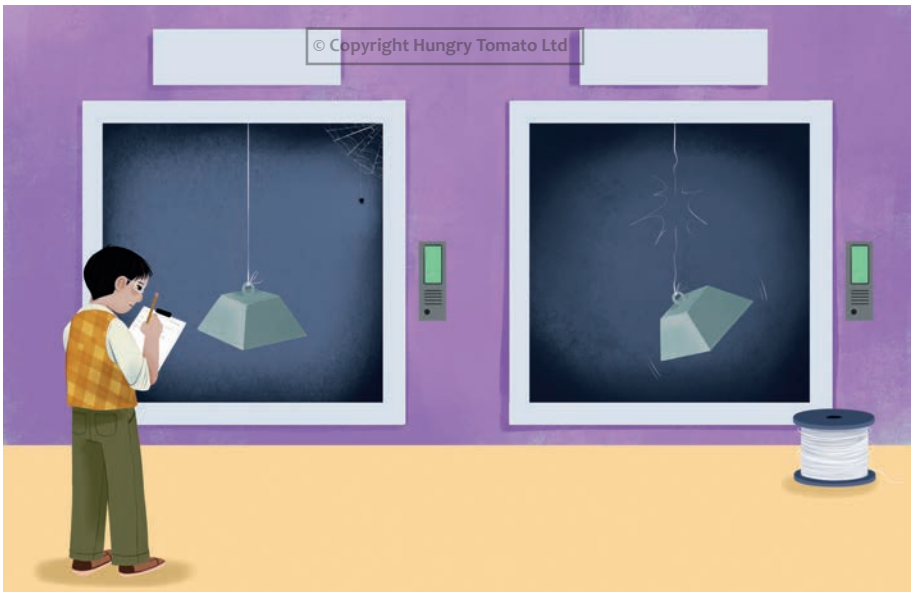
By studying how silk **resists** stretching and breaking, researchers learn how to design stronger ropes, fabrics, or other materials.

Observing spider webs also show them how nature distributes force efficiently, which has inspired **engineering** and **material science** designs.

SILK VS STEEL: SCENE 8

The material for this scene can be linked to curriculum topics, including: everyday materials and their uses; working scientifically.

Explore how scientists have compared spider silk to strong, human-made materials like steel. Use the visual of the arachnologist testing the silk with a weight to show how experiments reveal its incredible strength.



DISCUSSION PROMPTS

- **Why do scientists compare spider silk to materials like steel?**
  Information overleaf

- **What other factors must scientists bear in mind when conducting these kinds of experiments comparing two or more things?**
  Encourage children to consider other factors like dropping the weight at the same time, doing it on the same day, and so on.

- **What kinds of things might humans build if we could copy spider silk's properties?**
  Information overleaf

ACTIVITY

Corresponding activity on page 10 of the activity pack: 'Spider Swap' is a task where children match the photograph and name of a spider with its description. This activity shows the diversity of spiders that live on Earth.

SILK VS STEEL: SCENE 8

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

TESTING

To compare spider silk with human-made materials, scientists cut steel wires to the same **diameter** as the silk threads (measured in micrometres, millionths of a metre).

This lets them test both materials fairly under **tension** — how much they can be stretched before breaking. It helps them compare their abilities and properties when measured against the same test and work out once and for all which is stronger.

When conducting experiments comparing two or more things like this, scientists must be careful to keep all factors identical to ensure that the experiment is being done completely fairly, otherwise results will be **misleading**!

STRENGTH VS THICKNESS

Steel is strong in bulk, but when made extremely thin it becomes weaker and more **brittle**. Spider silk, however, stays tough even at **microscopic** thicknesses. This property makes it one of the strongest natural fibres known.

ONE OF THE WORLDS STRONGEST MATERIALS

Spider silk's combination of **tensile strength** (resistance to being pulled apart) and lightness means that, gram for gram, it outperforms steel and even some modern **synthetic** fibres like **Kevlar**.

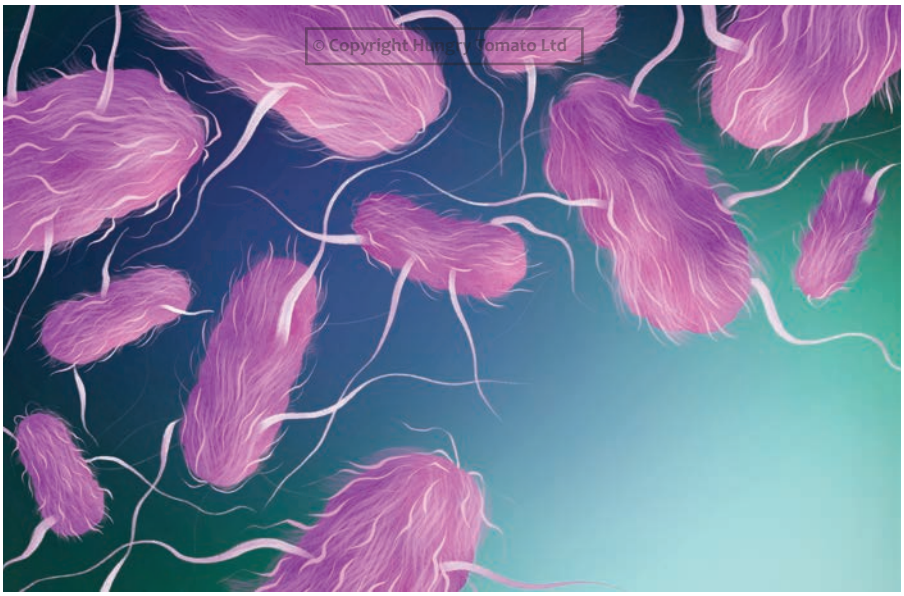
Scientists study its **proteins** and **structure** to learn how spiders make such an extraordinary material.

Not only does this help scientists better understand spider silk, it also helps them learn how to make other materials stronger.

THE RECIPE FOR SILK: SCENE 9

The material for this scene can be linked to curriculum topics, including: animals, including humans; living things and their habitats; working scientifically.

Show how scientists now use bacteria to make spider silk proteins instead of trying to harvest it from spiders. Discuss why farming silk from spiders is so difficult, comparing this with farming bacteria.



DISCUSSION PROMPTS

- **Why do scientists call spider silk a 'supermaterial'?**
  Information overleaf

- **Why do you think spiders are hard to farm for silk?**
  Information overleaf

- **How do bacteria help scientists make artificial spider silk?**
  Information overleaf

- **What kind of things might scientists make out of artificial spider silk?**

Encourage children to think about the properties of the material and possible uses. There is also information overleaf.

ACTIVITY

Corresponding activity on page 11 of the activity pack: 'A Message in the Web!' is a code-breaking activity where children have to align symbols and letters to decipher a message that's been hidden within a cobweb.

THE RECIPE FOR SILK: SCENE 9

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

SUPER SILK

Spider silk is an amazing **natural** fibre. Even though it's very thin, it can be stronger than steel of the same thickness. Some types can also stretch up to five times their own length without breaking. This mix of strength and stretchiness makes it one of the toughest natural materials we know. In fact, it is so impressive compared to other materials that scientists call it a 'supermaterial'.

Orb-weaving spiders, such as Araneus diadematus, make several different kinds of silk for building webs, wrapping **prey**, and protecting eggs.

HARVESTING SILK FROM SPIDERS

It's not possible to farm spiders for their silk — they only make small amounts and will often fight or eat each other if kept together. This means even a big 'spider farm' would only make a tiny amount of silk, not enough for making things on a large scale.

USING BACTERIA

To get around this problem, scientists copy the 'instructions' for spider silk from the spider's **DNA** and place them inside **bacteria** such as Escherichia coli (commonly known as E coli).

As these bacteria grow, they start to make the same silk **proteins** spiders do. These proteins can then be taken out of the bacteria and cleaned...

SPINNING ARTIFICIAL SILK

The silk proteins from bacteria are liquid, just like they are inside a spider. Scientists use special machines to copy what the spider does with its **spinnerets**, pulling and lining up the proteins to make solid fibres.

This creates **artificial** spider silk that acts a lot like the real thing. Many companies are already testing this silk to make strong, light fabrics, medical stitches, and even **eco-friendly** materials. Some of these uses are explored further later in this booklet as well as in the main book.

USING SILK TO STAY SAFE: SCENE 10

The material for this scene can be linked to curriculum topics, including: everyday materials and their uses; working scientifically.

Explain how scientists can now make large amounts of spider silk. Discuss how this silk is already being used for clothing and shoes, and how it could also be used to make protective gear stronger than today's vests.

DISCUSSION PROMPTS

- **Why is spider silk useful for making clothing and protective gear?**
  Information overleaf

- **What are some other things we already make from very strong materials?**

- **How might spider silk protective vests help people like police or firefighters?**
  Encourage children to think about the physical requirements of these jobs and how clothing affects this. There is also information overleaf.

- **What challenges do you think scientists might face when using spider silk in safety equipment?**

ACTIVITY

Corresponding activity on page 12 of the activity pack: 'Stunning Spider Facts' is a classic activity where children fill in the blanks in a series of sentences and facts about spiders, including how certain species behave.

USING SILK TO STAY SAFE: SCENE 10

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

SILK AT SCALE

Because real spiders can't be farmed for their silk, scientists use **bacteria** and other **organisms** to make spider silk **proteins** in large amounts.

This **artificial** spider silk behaves like the real thing, but can be produced in factories, making it possible to use for everyday items.

CLOTHING

Companies have already used artificial spider silk to make light, strong clothing, including jackets, dresses, and running shoes. These fabrics are **biodegradable**, meaning they break down naturally rather than adding to plastic waste. This makes them much better for the planet.

PROTECTIVE GEAR

Spider silk is much stronger than the same thickness of steel and can **absorb** a lot of energy without breaking.

Scientists believe it could be used to make safety equipment such as **bullet-resistant** vests, helmets, and ropes for rescue workers. Tests have shown that spider silk fibres can stop **projectiles** more effectively than some current **synthetic** fibres, like Kevlar.

WHY IT MATTERS

Using spider silk for protective gear could make equipment lighter and more flexible without losing strength. This would help people like police officers, firefighters, and soldiers move more easily while staying safe.

It might also reduce the **environmental impact** of making protective clothing because spider silk is made from **proteins**, not plastics.

BUILDING CELLULAR BRIDGES: SCENE 11

The material for this scene can be linked to curriculum topics, including: everyday materials and their uses; working scientifically.

Dive into some ways scientists are exploring new ways to use spider silk in medicine. Explain why its strength and flexibility make it useful for helping nerves and tissues heal, acting like a bridge that helps cells grow back together.

DISCUSSION PROMPTS

- **How could spider silk help doctors repair the body?**
  Information overleaf

- **Why is flexibility important for materials used inside the body?**
  Information overleaf

- **What parts of the body might benefit most from spider silk?**
  Information overleaf

ACTIVITY

Corresponding activity on page 13 of the activity pack: 'Discovering Spider Secrets' is a true or false quiz. Children use what they have learnt from reading the main book, as well as their intuition, to fill in the answers.

BUILDING CELLULAR BRIDGES: SCENE 11

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

MEDICINAL USES OF SILK

Spider silk is strong, flexible, and made from natural **proteins** that the body can safely accept. Because of this, it can be used inside living **organisms** without causing harm.

Scientists believe these **properties** could make spider silk useful for repairing **nerves** and **tissues** that have been damaged by injury or **disease**.

HELPING NERVES HEAL

Nerve cells (called **neurons**) don't easily grow back once damaged. Researchers have discovered that spider silk can act as a 'bridge' for these cells to grow across.

In experiments, silk fibres have been placed between two ends of an injured nerve. The cells use the silk as a path to reconnect, slowly restoring movement and feeling. This process has been successfully tested in animals such as rats.

Scientists have to be very careful when conducting any tests on animals to ensure that no harm is done to them. Some people say that any amount of testing on animals is not fair and shouldn't be done, no matter how careful scientists try to be.

WOUNDS AND TISSUE

Spider silk can also help skin and other tissues heal. Because it's gentle and flexible, it can be used as a natural bandage or stitching thread. The silk keeps the wound protected while allowing new **cells** to grow through it. Over time, the body can safely **absorb** the silk as the tissue repairs itself.

WHY IT WORKS

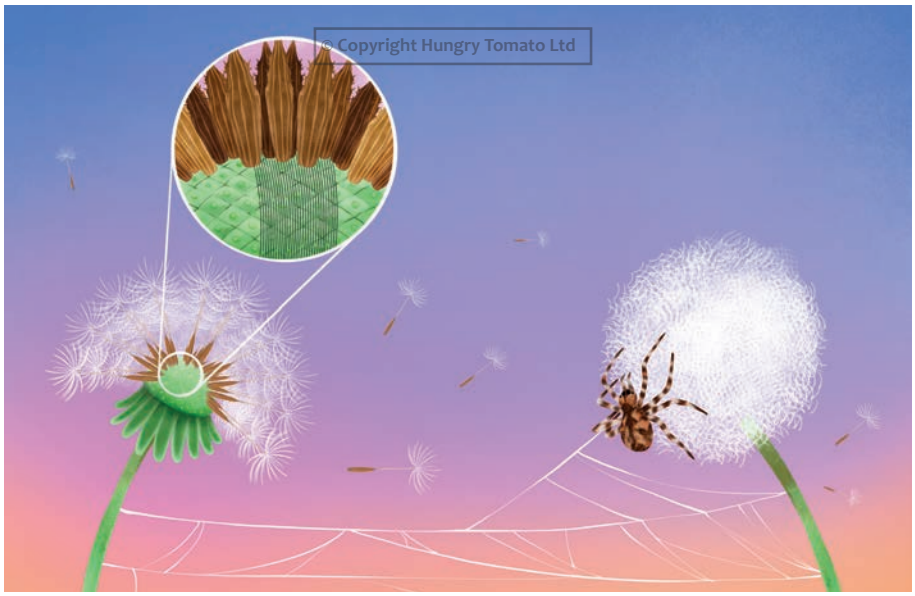
Unlike some **synthetic** materials, spider silk doesn't cause the body's **immune system** to react badly. It's **biodegradable**, **non-toxic**, and very strong for its size.

These qualities make it an exciting material for doctors and **biomedical engineers** who want to design better ways to help the body heal itself.

BIOSENSORS: SCENE 12

The material for this scene can be linked to curriculum topics, including: everyday materials and their uses; working scientifically.

Explain how scientists are using real spider silk to make tiny sensors that can collect information about the environment. Show how these silk-based sensors can be placed on delicate things like flowers to help scientists study and protect nature.



DISCUSSION PROMPTS

How can spider silk be turned into a sensor?
Information overleaf

Why do scientists need sensors to study nature?
Information overleaf

What kinds of information might these silk sensors collect?
Information overleaf

Why is spider silk a good material for tiny, delicate devices?
Information overleaf

ACTIVITY

Corresponding activity on page 14 of the activity pack: 'Cobweb Queries' is a reflective writing task where children answer questions about their opinions on a number of spider-related questions.

BIOSENSORS: SCENE 12

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

SENSORS

Spider silk is not only strong — it's also very thin, light, and flexible, which makes it perfect for use in delicate technology. Scientists have discovered ways to turn real spider silk into sensors by coating it with tiny amounts of **electricity-conducting** materials such as graphene or metal **nanoparticles**. These sensors can detect changes in temperature, **humidity**, movement, or pressure.

HOW IT'S MADE

Researchers use spider silk from **species** such as the golden orb-weaver (scientific name 'Nephila clavipes'), known for its strong and uniform threads. The silk is treated so it can carry tiny **electrical signals**. When the silk bends, stretches, or **absorbs** moisture, its electrical **properties** change. This allows it to act like a sensor, sending information back to computers for scientists to study.

WHY IT WORKS

Silk is naturally soft and **biodegradable**, so it can be used on living things without causing damage. Scientists have even printed silk sensors onto leaves, flower petals, and human skin. Because the silk eventually breaks down safely, it doesn't harm plants or animals and can be used for short-term studies in nature.

HOW SENSORS HELP

By placing spider silk sensors in forests, oceans, and cities, researchers can collect **data** on **air pollution**, **soil moisture**, and **climate** changes. This helps scientists understand how healthy an **environment** is and how to better protect it.

These same sensors could one day be used to monitor **crops**, track animal movements, or measure the effects of **global warming.**

SPIDERWEBS STRONGER THAN STEEL: SCENE 13

The material for this scene can be linked to curriculum topics, including:
everyday materials and their uses; working scientifically.

Show how scientists study spider silk to learn how it could make materials like metal or concrete stronger. Discuss how while spider silk is extremely tough, it's too light and flexible to support very heavy structures like bridges by itself.

DISCUSSION PROMPTS

- **Why can't spider silk be used to build large structures like bridges?**
  Information overleaf

- **How could adding spider silk to metals or other materials make them stronger?**
  Information overleaf

- **What makes spider silk different from materials like steel or concrete?**
  Information overleaf

- **Can you think of any other natural materials that inspire engineers?**
  Information overleaf

ACTIVITY

Corresponding activity on page 15 of the activity pack: 'Spot the Spider' is an odd one out activity where children must spot the spider that stands out from the rest.

SPIDERWEBS STRONGER THAN STEEL: SCENE 13

RELEVANT INFORMATION

Keywords that you may want to pull out and explain have been put into bold.

SILK AND ENGINEERING

Spider silk has inspired scientists and **engineers** to rethink how materials can be both light and strong at the same time. Although spider silk is tougher than steel of the same thickness, it can't hold up heavy structures like buildings on its own because it's not rigid enough — it stretches instead of staying firm.

In **engineering**, stiffness is just as important as strength when building things like bridges or skyscrapers.

COMBINING SILK AND MATERIALS

Researchers are experimenting with ways of adding spider silk **proteins** to metals, plastics, and carbon fibres to create new, improved materials. When mixed in small amounts, silk can make materials more flexible, resistant to breaking, or less likely to crack under pressure. Scientists are especially interested in using it in lightweight aircraft parts or protective coatings.

BIOMIMICRY

Spider silk is part of a larger field of **biomimicry**, where **engineers** copy designs found in nature. By studying how silk's structure works at the **microscopic** level, scientists hope to design human-made fibres with the same balance of toughness and elasticity. One idea is to create construction materials that can bend in strong winds or during earthquakes without breaking.

WHY IT CAN'T REPLACE STEEL

Even though spider silk is very strong for its size, it can't compare to the total strength of steel cables or concrete beams used in bridges. A spider web large enough to hold a bridge would weigh very little but stretch too much to stay stable. Instead of replacing metals, scientists are looking for ways to combine silk-like materials with stronger substances to make smarter, more flexible structures.

POST-READING QUESTIONS

Engage in discussion about the journey taken throughout the book and the facts that were uncovered, with the suggested questions below.

- **Is spider silk stronger than steel?**
- **Did anything else in the book surprise you?**
- **What's the coolest thing you've learnt from this book?**

ACTIVITY

Corresponding activity on page 16 of the activity pack: 'Symmetrical Spider' is a draw the other half' activity where children have been given an image of a spider split down the middle to complete.

DISCLAIMER:

Every effort has been made to ensure the information in this booklet is correct as of the time of publication, Autumn 2025.

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