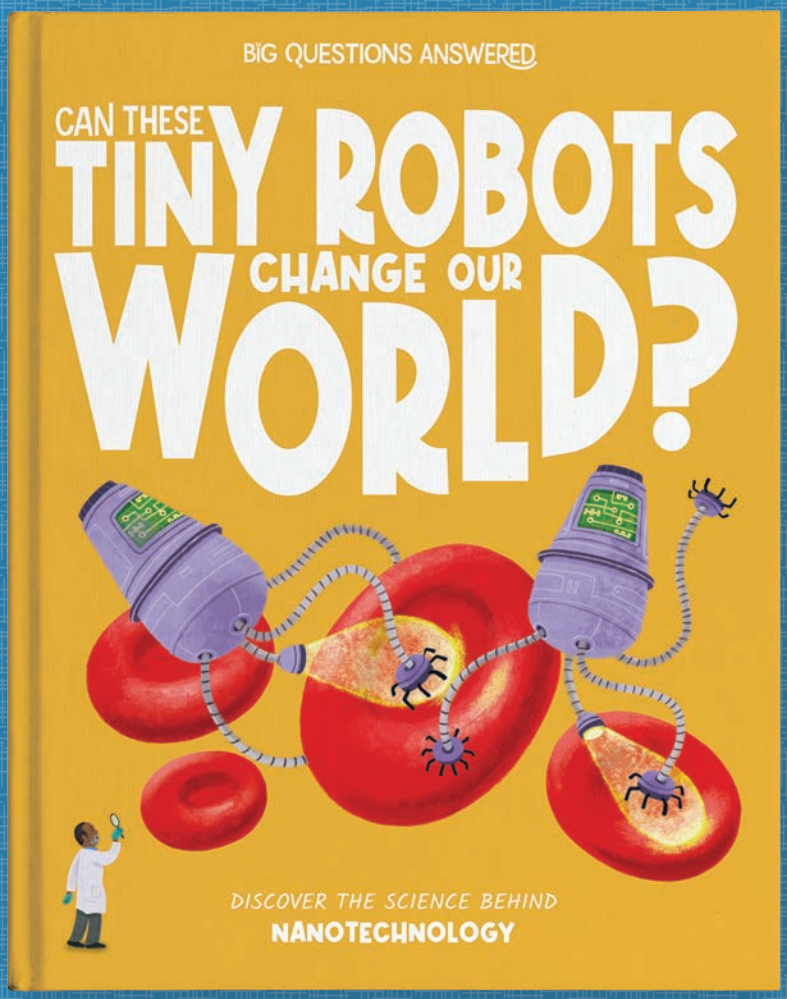
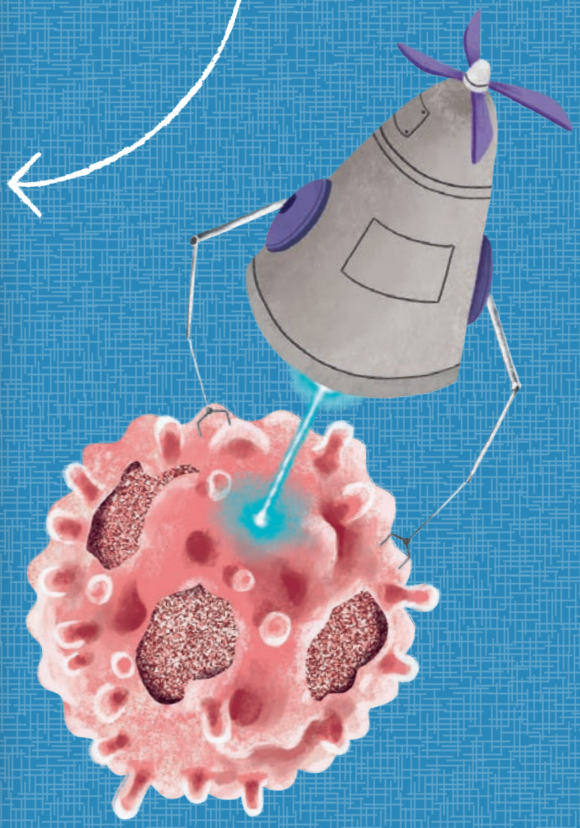
BIG QUESTIONS ANSWERED

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

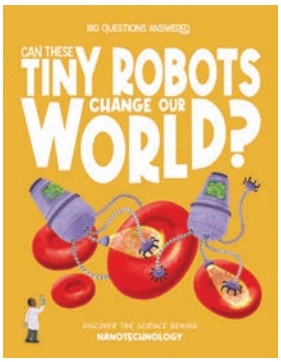
Inspire children's natural curiosity, improve literacy, and have fun learning about different sciences with The Big Questions Answered. Each book in the series is accompanied by a selection of fantastic, **FREE** downloadable resources.

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**

Can These Tiny Robots Change Our World? book



Young Nanotechnologists' Activity Pack

KEY CURRICULUM TOPICS

The resources related to *'Can These Tiny Robots Change Our World?'* tie in with key curriculum topics including:

- Animals, including humans
- Climate change
- Computing
- Earth and space
- Everyday materials and their uses
- Living things and their habitats
- Working scientifically

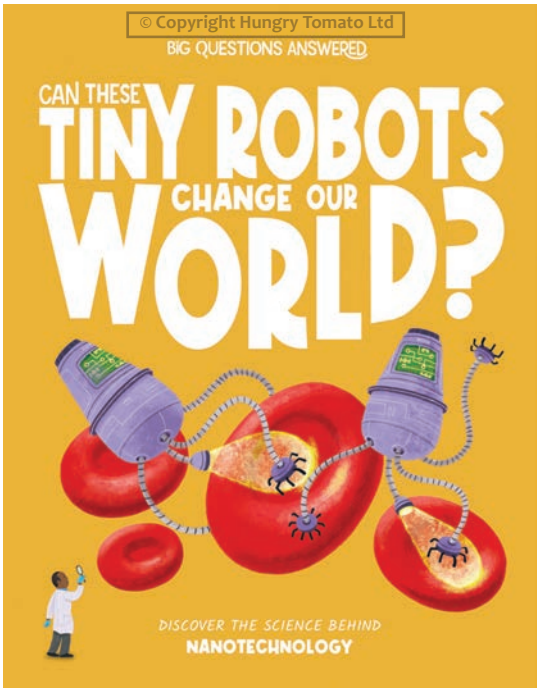
The most relevant topics are indicated throughout this guide.

CAN THESE TINY ROBOTS CHANGE OUR WORLD?

This book explores the extraordinary world of nanotechnology. As well as covering what nanotechnology is and what it can do, this book explores the different ways it can impact daily life – now, and in the future! With modern and futuristic themes, this book also covers the risks and benefits of nanot nanotechnology, and the vast ways it can be used to advance technology.

PRE-READING QUESTIONS

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



- What do you know about nanotechnology already?
- What do you know about robots already?
- Do you think it's possible for tiny robots to change our world? Why or why not?

THE FUTURE OF PLANET EARTH: SCENE 1

The material for this scene can be linked to curriculum topics, including:
animals, including humans; climate change; computing; working scientifically.

Consider what the world will be like many years in the future with this imaginative, futuristic scene. Encourage children to think about the different ways that life may be different, focusing on the possible impact of technology and robotics.

DISCUSSION PROMPTS

- **What do you think the world will be like in the future?**

Encourage children to think about how people's everyday lives will be different due to machinery and factors like climate change. There is also information overleaf.

- **Do you think the world will be better or worse in the future? Why do you think this?**

- **Do you think we will one day live alongside robots like the people are doing in this scene?**

- **If you could invent an amazing, high-tech robot, what would you want it to be able to do?**

ACTIVITY

Corresponding activity on page 3 of the activity pack: 'Nano Tricksters' is a spot the difference activity where there are 6 differences for children to find across 2 versions of this scene.

THE FUTURE OF PLANET EARTH: SCENE 1

RELEVANT INFORMATION

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

IMAGINING THE FUTURE

People have been imagining the future for centuries, from stories about flying machines in **ancient Greece** to the **science fiction** of the 20th century.

Popular images of the future often include human-like **robots**, cities filled with technology, and vehicles that fly through the air. These ideas reflect our hopes about what science and **engineering** might achieve.

BIG PROBLEMS TO SOLVE

Scientists today are focused on solving global challenges such as curing **diseases** like cancer, finding cleaner **energy sources**, and reducing the effects of **climate change**.

These problems may seem enormous, but researchers believe that advances in very small-scale science could play an important role in finding solutions.

THINKING SMALL

Nanotechnology is the study and use of things at the scale of nanometres. One nanometre is one billionth of a metre. At this scale, objects are too small to be seen with a regular **microscope**.

By understanding and controlling materials at this size, scientists can design new tools and processes that may one day transform medicine, energy, and technology.

INTRODUCING THE NANOMETRE: SCENE 2

The material for this scene can be linked to curriculum topics, including:
Earth and space; computing; working scientifically.

Introduce children to what nanotechnologists do. Discover their special unit of measurement – the nanometre – through this fun scene which shows the scale of a nanometre by comparing a golf with the Earth.

DISCUSSION PROMPTS

- **Why do nanotechnologists need very strong microscopes?**
Information overleaf

- **What is a nanometre, and why do scientists use it?**
Information overleaf

- **Can you think of any of your own size difference equivalents, like a golf ball and Earth?**

ACTIVITY

Corresponding activity on page 4 of the activity pack: 'Microscopic Word Hunt' is a word search activity which encourages children to find and circle words nanotechnologists use on a daily basis.

INTRODUCING THE NANOMETRE: SCENE 2

RELEVANT INFORMATION

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

WHAT NANOTECHNOLOGISTS DO

Nanotechnologists are scientists and engineers who work at the nanoscale – the world of **atoms** and **molecules**.

At this scale, objects are invisible to the human eye and require powerful instruments such as **scanning tunnelling microscopes** (STM) or **atomic force microscopes** (AFM) to study. These tools allow researchers to 'see' and even move single atoms.

THE NANOMETRE

Because nanotechnology deals with extremely small structures, scientists use the nanometre (nm) as a unit of measurement.

One nanometre is one billionth of a metre (1 nm = 0.000000001 m). To give perspective, a human hair is about 80,000–100,000 nanometres wide, and a **red blood cell** is roughly 7,000 nanometres across.

COMPARING SCALES

Working at the nanoscale is often compared to space exploration, since both involve entering environments that cannot be experienced with our normal senses. Just as astronauts need special suits and vehicles to explore the Moon, nanotechnologists need **specialised** microscopes and tools to navigate the **atomic** and **molecular** world.

NANOBOTS IN BLOODSTREAMS: SCENE 3

The material for this scene can be linked to curriculum topics, including:
animals, including humans; computing; working scientifically.

Introduce nanobots, the tiny robots that nanotechnologists are designing that are small enough to move inside the human body. Use the visual of nanobots in the bloodstream to show how they work in places far too small for doctors' hands.

DISCUSSION PROMPTS

- **What are nanobots, and how are they different from regular robots?**
  Information overleaf

- **Why is the bloodstream a useful place for nanobots to travel?**
  Information overleaf

- **How might nanobots help doctors treat patients?**
  Information overleaf

- **Can you think of any challenges that nanotechnologists might face when designing nanobots?**
  Information overleaf

ACTIVITY

Corresponding activity on page 5 of the activity pack: 'Small Scale Symmetry' is a 'complete the drawing' activity where children are given an image of a nanobot split down the middle and they have to complete the drawing.

NANOBOTS IN BLOODSTREAMS: SCENE 3

RELEVANT INFORMATION

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

NANOBOTS

Nanobots are **theoretical** or **experimental** machines built at the **nanoscale**, often measuring only a few hundred nanometres across. At this size, they are smaller than many **cells** in the human body.

Researchers design nanobots using **molecular** parts, with the goal of performing precise tasks in environments too small for traditional tools.

INSIDE THE BODY

The human bloodstream provides a natural 'road system' for nanobots to move through. Blood vessels carry **oxygen, nutrients,** and **cells** throughout the body, and nanobots could travel alongside them to deliver medicine or repair damaged **tissue**. Because nanobots are so small, they could enter areas unreachable by even the finest **surgical** instruments.

POSSIBLE MEDICAL USES

Scientists are exploring several medical applications for nanobots. These include:

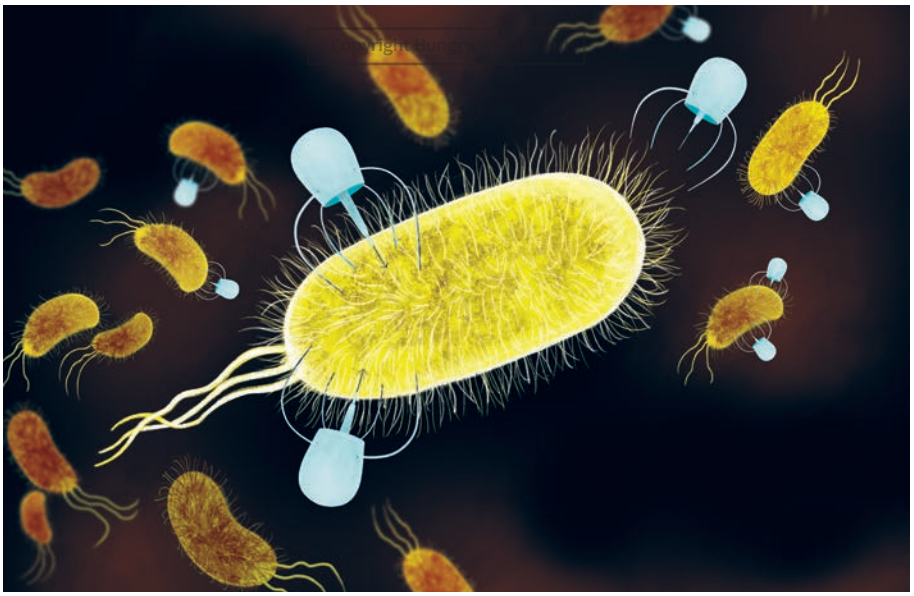
- destroying harmful cells
- repairing damaged **DNA**
- delivering targeted medicines to **diseased** cells (while leaving healthy ones untouched)
- performing **microsurgeries** at the **cellular** level.

Experiments are still in early stages, but the potential uses highlight how powerful nanoscale engineering could be in healthcare. Plus, who knows what other uses doctors, scientists, and engineers will discover for nanotechnology.

BOTS VS BACTERIA: SCENE 4

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

Explain how scientists are designing nanobots to fight harmful things in the body, like bacteria and cancer cells. Use the visual of nanobots attacking bacteria to show how they might target diseases directly.



DISCUSSION PROMPTS

- **How might nanobots destroy bacteria or cancer cells?**
  Information overleaf

- **Why would targeting harmful cells directly be useful for doctors?**
  Information overleaf

- **How is this different from the medicines we use today?**
  Information overleaf

ACTIVITY

Corresponding activity on page 6 of the activity pack: 'Tiny Tech Tales' is a creative writing activity which encourages children to write a story about nanotechnology, using three key prompt words.

BOTS VS BACTERIA: SCENE 4

RELEVANT INFORMATION

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

NANOBOTS AND DISEASE

Traditional medicines, such as **antibiotics** or **chemotherapy**, affect large areas of the body and can harm healthy **cells** as well as diseased ones.

Nanobots are being designed to act with much greater precision. By drilling into or breaking apart harmful bacteria or **cancer** cells, nanobots could attack only the **disease**, while leaving healthy tissue unharmed.

TARGETING BACTERIA

Bacteria are **single-celled organisms**, many of which can cause disease in humans.

Nanobots small enough to enter a **bacterium** could destroy it from within, either by **mechanical** action (drilling or cutting) or by releasing medicine directly into the cell. This level of precision could help fight infections more effectively than antibiotics.

TARGETING CANCER CELLS

Cancer begins when cells in the body grow out of control. Current treatments like chemotherapy kill both cancerous and healthy cells, which can make patients very sick.

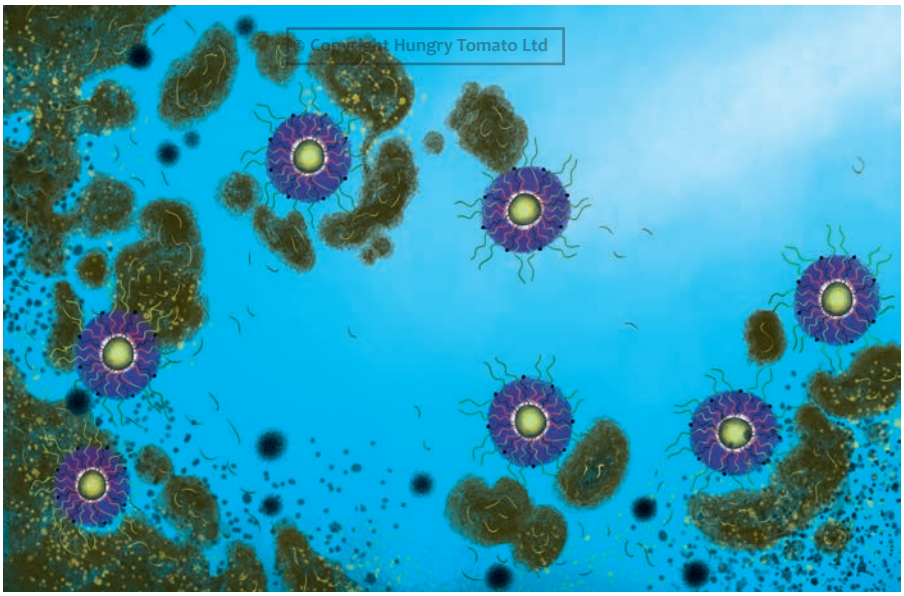
Nanobots could be designed to identify cancer cells by recognising certain **proteins** on their surface. Once inside, they could destroy the cancer cell without affecting the healthy ones nearby.

This is a very interesting area of science and engineering which many different experts are keen to learn more about, as it could have a huge impact on how we treat illnesses.

CLEANING OUR WATER: SCENE 5

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

Discover another up and coming way that nanotechnology could change the world with this scene which shows nanobots cleaning bacteria from water. Discuuss why this would be a beneficial thing to acheive.



DISCUSSION PROMPTS

- **How might nanobots remove pollution or viruses from water?**
  Information overleaf

- **What problems could clean water help solve around the world?**
  Information overleaf

- **Can you think of other ways science helps us keep water safe to drink?**

- **Why is clean water important for humans, animals, and plants?**
  Information overleaf

ACTIVITY

Corresponding activity on page 7 of the activity pack: 'Race to Recharge' is a classic line maze activity where children help a nanobot reach its charging station by identifying the correct route.

CLEANING OUR WATER: SCENE 5

RELEVANT INFORMATION

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

NANOBOTS IN THE ENVIRONMENT

The uses of nanotechnology are not limited to medicine – it can also be applied to **environmental** challenges. Water **pollution** is one of the world's biggest problems, with harmful **viruses**, **bacteria**, and **chemicals** making water unsafe to drink.

Scientists are designing nanobots that could move through water and capture or break down dangerous substances.

REMOVING POLLUTANTS

Some nanobots are built to attract and stick to **pollutants** such as heavy metals, **pesticides**, or plastics. Others are designed to destroy harmful **microorganisms**, like viruses, by cutting them apart or deactivating them.

Because nanobots are so small, they can move easily between water molecules, reaching **contaminants** that larger filters cannot remove.

GLOBAL IMPORTANCE OF WATER

According to the World Health Organization, billions of people around the world still lack access to safe drinking water. Polluted water can spread diseases and harm wildlife.

Technologies that can quickly and effectively clean water would improve health and safety for humans, animals, and plants across many environments.

REPAIRING THE ATMOSPHERE: SCENE 6

The material for this scene can be linked to curriculum topics, including:
Earth and space; climate change; computing; working scientifically.

Discover how nanobots could be used to help the environment, not just the human body. Use the visual of the satellite and Earth to discuss why the ozone layer is important.

DISCUSSION PROMPTS

- **What is the ozone layer and why is it important for life on Earth?**
  Information overleaf

- **How might nanobots help repair the ozone layer?**
  Information overleaf

- **What could happen if the ozone layer is not repaired?**
  Information overleaf

- **Can you think of other ways humans have tried to protect the environment?**
  Information overleaf

ACTIVITY

Corresponding activity on page 8 of the activity pack: 'Changing World' is a classic crossword activity where children use clues to pair words and their meaning to fill in the spaces.

REPAIRING THE ATMOSPHERE: SCENE 6

RELEVANT INFORMATION

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

THE OZONE LAYER

The **ozone** layer is a layer of ozone **gas** (O_3) in Earth's **stratosphere**, about 15–35 km (9–22 miles) above the surface which absorbs most of the Sun's harmful **ultraviolet** (often shortened and called UV) radiation.

Human activities, especially the use of **chlorofluorocarbons** (CFCs) in the 20th century, have caused thinning in parts of the ozone layer, known as ozone depletion.

CFCs used to be used in items like refridgerators, aerosol cans, certain types of plastics, and more. However, they are now banned in many places due to their negative impact on the **environment**.

REPAIRING THE ATMOSPHERE

Scientists have proposed that nanobots could be sent up into the stratosphere to help repair the ozone layer. These nanobots might carry or release chemicals that convert harmful **compounds** back into oxygen or ozone.

Because nanobots are extremely small, they could travel through the atmosphere efficiently, potentially reaching areas that are otherwise difficult to treat with conventional methods.

GLOBAL IMPACT

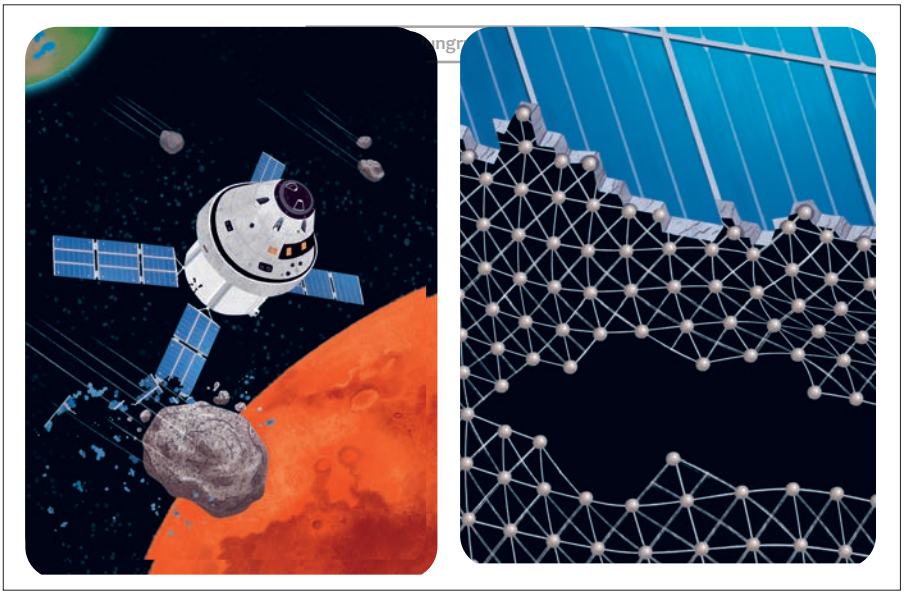
A damaged ozone layer increases UV radiation reaching Earth, which can harm human health, damage plants, **crops**, and **marine life**, and affect **ecosystems**.

Repairing the ozone layer would reduce these risks, protecting both people and wildlife. Understanding how nanotechnology might help highlights how tiny machines could one day assist in solving big-scale problems for our planet.

REPAIRS IN SPACE: SCENE 7

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

Explore how nanotechnology could allow nanobots to repair spacecraft while they are in space, helping missions last longer. Also discuss how scientists can change the properties of materials at the nanoscale to make them lighter and stronger.



DISCUSSION PROMPTS

- **How might nanobots repair spacecraft in space?**
  Information overleaf

- **Why would repairing spacecraft while in orbit be useful for long missions?**
  Information overleaf

- **How can changing materials at the nanoscale make spacecraft stronger or lighter?**
  Information overleaf

- **Can you think of other materials that might benefit from nanoscale improvements?**

ACTIVITY

Corresponding activity on page 9 of the activity pack: 'Tiny Tech Tales' is a fact file activity where children can research a nanotechnology invention of their choosing and answer fun questions about it.

REPAIRS IN SPACE: SCENE 7

RELEVANT INFORMATION

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

NANOBOTS IN SPACE

Nanobots can be designed to perform repairs in environments too dangerous or **inaccessible** for humans. In outer space, satellites and spacecraft are exposed to extreme temperatures, **radiation**, and impacts from **micrometeoroids** or **debris**.

Nanobots could be programmed to detect damage and perform repairs, such as patching small cracks or restoring damaged circuits, extending the **operational** life of the spacecraft as well as the length of the mission.

MATERIAL ENGINEERING

Nanotechnologists can modify materials at the nanoscale, arranging **atoms** and **molecules** in precise ways to change the material's **properties**.

This can make metals lighter but stronger, **ceramics** more heat-resistant, or **polymers** more flexible.

Applying these advances to spacecraft materials can improve **durability** while reducing how much the spacecraft weighs, which is critical for long-distance space missions.

SPACE MISSIONS

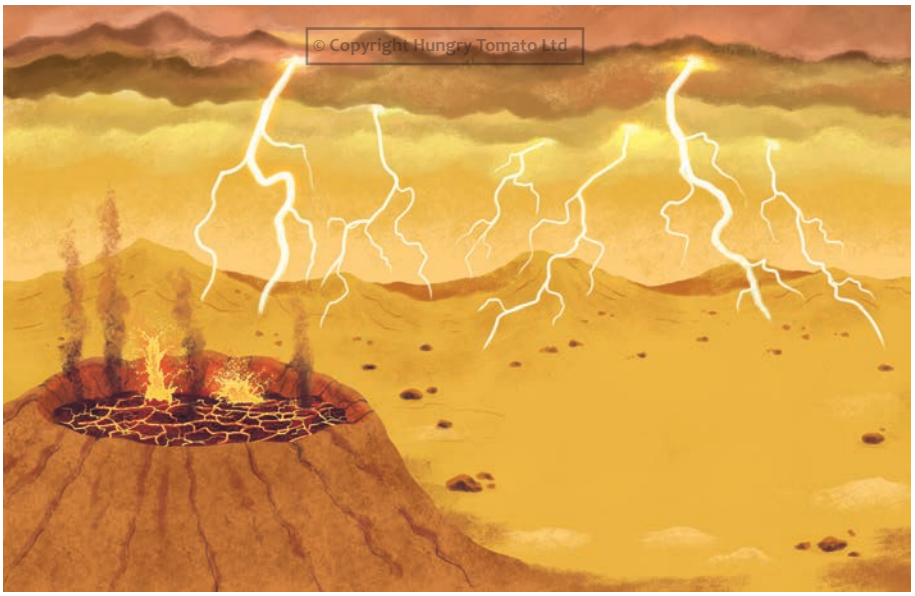
Combining nanobot repairs and nanoscale material improvements could help **satellites**, **space stations**, and **deep-space probes** survive longer missions. This technology could reduce costs, improve safety, and allow scientists to explore further into outer space than ever before.

These improvements are now more important than ever as people from around the world are working on plans to travel back into space over the next few decades. This technology could change the way we plan space missions, from the ways experts design spacecraft to the routes they'll take, and more!

TESTS ON VENUS: SCENE 8

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

Discover why nanomaterials must be created to survive harsh conditions and how scientists are testing them on planets such as Venus to see how they handle these challenging conditions.



DISCUSSION PROMPTS

- **What kinds of harsh conditions must nanomaterials survive?**
  Information overleaf

- **Why is Venus a good place to test these materials?**
  Information overleaf

- **How could testing nanomaterials in space help us explore extreme environments on Earth?**
  Information overleaf

- **Can you think of any places on Earth that are too dangerous for humans but could be studied with nanotechnology?**
  Information overleaf

ACTIVITY

Corresponding activity on page 10 of the activity pack: 'Nano Think Tank' is a reflective writing activity that encourages children to use what they have learnt from the book, and their intuition, to answer a series of questions.

TESTS ON VENUS: SCENE 8

RELEVANT INFORMATION

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

HARSH CONDITIONS

Nanomaterials must be designed to cope with extreme environments. In space, temperatures can swing from hundreds of degrees above zero in sunlight to hundreds of degrees below zero in shadow.

High levels of **radiation** from the Sun and **cosmic** rays can damage ordinary materials. On Venus, surface temperatures reach around 465 °C (869 °F), and clouds contain **sulfuric acid rain**. Nanomaterials tested there must resist **corrosion**, heat, and **chemical** attack.

TESTING NANOMATERIALS

Scientists often test materials under **simulated** extreme conditions in laboratories, but it can be hard to recreate these conditions safely on Earth, so it can be more effective for some experiments to be done on-site on planets, moons, or in **orbit**.

Venus provides an opportunity to study how materials perform in intense heat, **pressure**, and **chemical exposure**. Lessons from these tests can inform the design of machines for extreme Earth environments as well.

APPLICATIONS ON EARTH

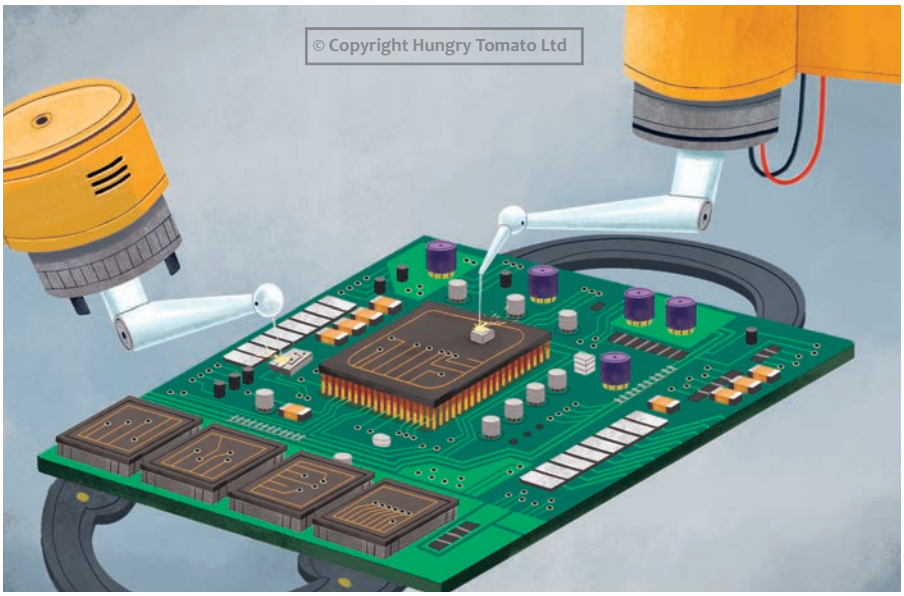
Nanomaterials developed for space exploration can also be used in extreme environments on Earth, such as near deep-sea volcanoes, in **habitats** like Arctic tundras or deserts, or areas with **toxic** chemicals.

By learning how to make machines that are able to survive harsh conditions, scientists can study places humans cannot safely visit, expanding our understanding of both Earth, the solar system, and deep in outer space.

IMPOSSIBLE ELECTRONICS: SCENE 9

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

Explore how nanotechnology allows engineers to make electronics much smaller and more precise. Use the visual of a microchip being assembled to show how nanotechnology helps create incredibly small, complex devices.



DISCUSSION PROMPTS

- **How does working at the nanoscale allow engineers to make smaller, more powerful electronics?**
  Information overleaf

- **What kinds of devices can be made using nanotechnology?**
  Information overleaf

- **Can you think of ways these tiny devices could be used in everyday life or in different industries?**

Encourage children to discuss other factors that make these products useful, such as security, surveillance, using less electricity, etc. There is also information overleaf.

ACTIVITY

Corresponding activity on page 11 of the activity pack: 'A Secret Code!' is a decoding activity where children have to decode a message from a nanobot by using the icons and the corresponding letters.

IMPOSSIBLE ELECTRONICS: SCENE 9

RELEVANT INFORMATION

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

PRECISION ELECTRONICS

Nanotechnology enables **engineers** to work at the scale of **atoms** and **molecules**, allowing for extremely **precise** construction of electronic components.

Microchips, which process and store information, can now be made smaller while holding more data because nanoscale techniques allow **circuits** to be packed more tightly. This, in turn, helps experts make the machines that require microchips to be made smaller and lighter too!

APPLICATIONS

Nanoscale electronics can be used in computing, medical devices, robotics, and environmental sensors.

For example, microchips in smartphones, nanodrones for **surveillance** or research, and ultra-thin sensors for vehicles all rely on nanoscale manufacturing.

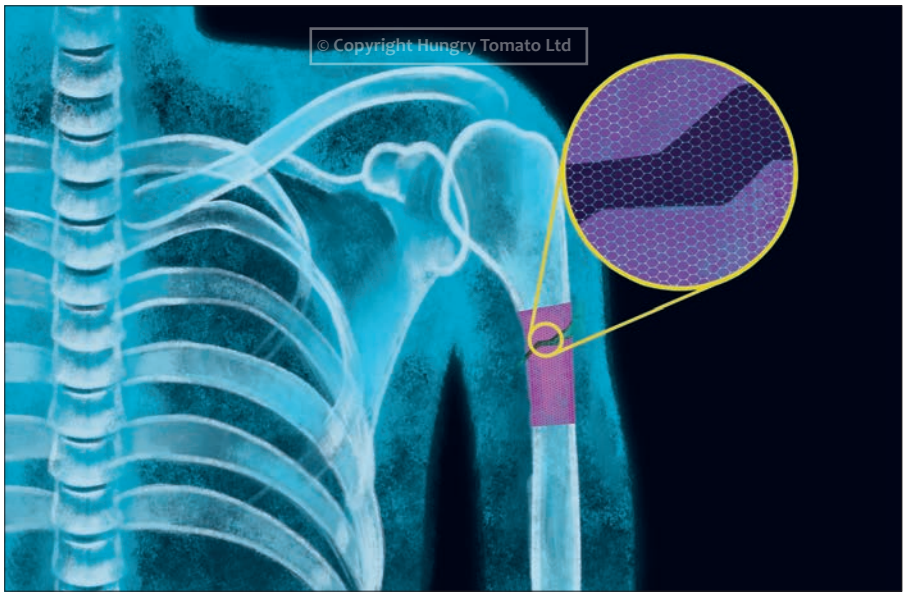
These innovations demonstrate how controlling matter at the smallest scale can transform technology and daily life.

Plus, as science and technology continues to develop, these tiny electronics could be used in even more new and exciting ways. This is a constantly developing area of study.

HEALING HUMANS: SCENE 10

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

Discover how nanomaterials aren't just for electronics, they can also help the human body heal. Use the visual of the broken arm with nanotechology mesh to show how these materials could act as a framework for healing.



DISCUSSION PROMPTS

- **How can nanomaterials help the body repair itself?**
  Information overleaf

- **Why would growing tissue or bone around a nanostructure be useful for doctors?**
  Information overleaf

- **What challenges do you think scientists face when testing nanostructures for organs?**
  Information overleaf

ACTIVITY

Corresponding activity on page 12 of the activity pack: 'Nano Wonders' is a fun fill in the blanks activity for children to use a list of words to complete the interesting facts.

HEALING HUMANS: SCENE 10

RELEVANT INFORMATION

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

MEDICINE

Nanomaterials can be designed with special shapes and surfaces that encourage **cells** within a living thing's body to act or grow in a certain way.

Doctors can place these structures in the body where **tissue** has been damaged, such as in broken bones or severe burns. Over time, cells grow around the nanostructure, gradually repairing the injury with new, healthy tissue.

BONE AND TISSUE

When bones break, traditional treatments like casts only hold the bone in place while it heals naturally. Nanostructures offer an additional benefit: they provide a **scaffold** that bone cells can grow onto, speeding up recovery and improving strength.

In cases of burns, nanoscale meshes can help skin cells grow over **wounds** more quickly and evenly.

GROWING ORGANS

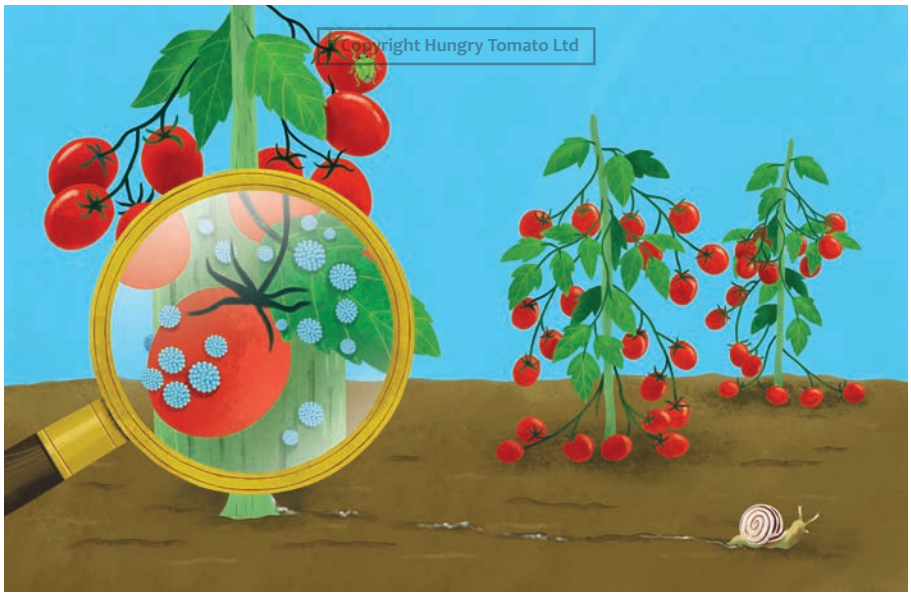
Scientists are experimenting with nanostructures to act as **frameworks** for growing entire **organs**, such as kidneys or livers. By encouraging cells to grow in specific patterns, nanotechnology may one day allow doctors to replace damaged organs with **lab-grown** alternatives.

This research is still experimental, and there's a lot that experts still need to learn, but it shows the potential for nanotechnology to transform medicine.

FASTER FOOD: SCENE 11

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

Explore how nanotechnology can also help grow food. This scene shows nanobots through a magnifying glass on tomato plants as a way of introducing how nanoscale science could support farming.



DISCUSSION PROMPTS

- **How could nanoparticles help plants grow better?**
  Information overleaf

- **Why might using fewer chemical fertilisers be good for the soil and environment?**
  Information overleaf

- **What foods do you think could benefit from nanotechnology in farming?**

ACTIVITY

Corresponding activity on page 13 of the activity pack: 'True or Tiny?' is a true or false quiz. Children use what they have learnt from reading the main book to work out whether the sentences related to nanotechnology are true or false.

FASTER FOOD: SCENE 11

RELEVANT INFORMATION

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

AGRICULTURE

Farming often depends on **fertilisers**, which add nutrients like **nitrogen** and **phosphorus** to soil because these substances help keep soil healthy for plants to grow in.

However, too much fertiliser can wash into rivers and lakes, causing pollution. Certain fertilisers can be harmful to animals and bugs.

Nanoparticles can be designed to deliver nutrients directly to plants in a form that is easier to **absorb**, meaning less fertiliser is needed, less waste enters the environment, and less harm is caused to other living things in the area.

NUTRIENT DELIVERY

Nanoparticles can attach to plant roots or leaves, slowly releasing nutrients like **iron**, **zinc**, or nitrogen. Because these particles work at the nanoscale, plants absorb them more effectively than larger fertiliser **molecules**. This process helps plants grow stronger and produce more food.

ENVIRONMENTAL BENEFITS

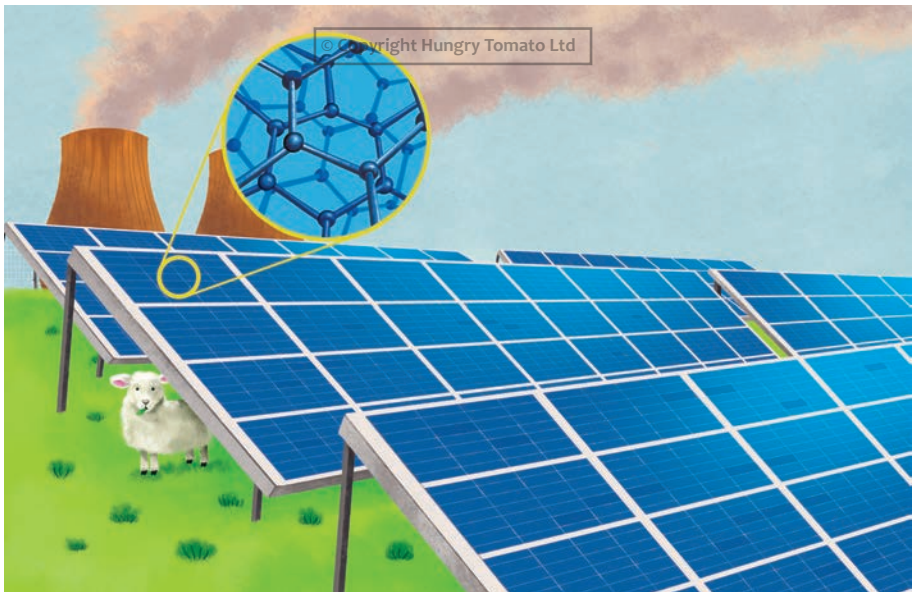
Reducing the use of **chemical** fertilisers helps protect soil, water, and nearby **ecosystems**. Nanotechnology in **agriculture** could lower pollution, improve crop **yields**, and make farming more **sustainable**.

These benefits are especially important as our global population continues to grow and demand for food increases.

PROTECTING THE PLANET: SCENE 12

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

Dive into the ways that nanomaterials can help protect the planet with this scene focusing on solar panels. Discuss how nanotechnology can reduce pollution and increase clean energy, and why this is important.



DISCUSSION PROMPTS

- **How might nanomaterials help reduce harmful gases in the air?**
  Information overleaf

- **Why would replacing plastics in electronics be good for the environment?**
  Information overleaf

- **How do solar panels use the Sun's energy, and how could nanotechnology make them better?**
  Information overleaf

- **Why is reducing pollution important?**

- **Can you think of other ways nanotechnology might help protect the planet?**

ACTIVITY

Corresponding activity on page 14 of the activity pack: 'Match the Marvel' is a match-up activity where children must match up the nanoscale shape and name with its description.

PROTECTING THE PLANET: SCENE 12

RELEVANT INFORMATION

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

CAPTURING HARMFUL GASES

Air pollution from factories, vehicles, and chemical plants releases **gases** such as **carbon dioxide** (CO_2), **nitrogen oxides** (N_2O), and **sulfur dioxide (SO_2)** into the **atmosphere**.

These gases are bad news because they make the planet hotter, contributing to **global warming** and they can be really hard to get rid of.

Nanomaterials can be engineered with tiny **pores** or chemical **coatings** that trap or break down these harmful gases, improving air quality and reducing **greenhouse effects**.

REPLACING PLASTICS

Plastics are commonly used in electronics like batteries and screens, but they are not **biodegradable** and can create large amounts of waste.

Nanomaterials such as **graphene** and **nanocellulose** are strong, flexible, and lightweight alternatives that could replace plastics in many devices, reducing long-term **pollution**.

IMPROVING SOLAR PANELS

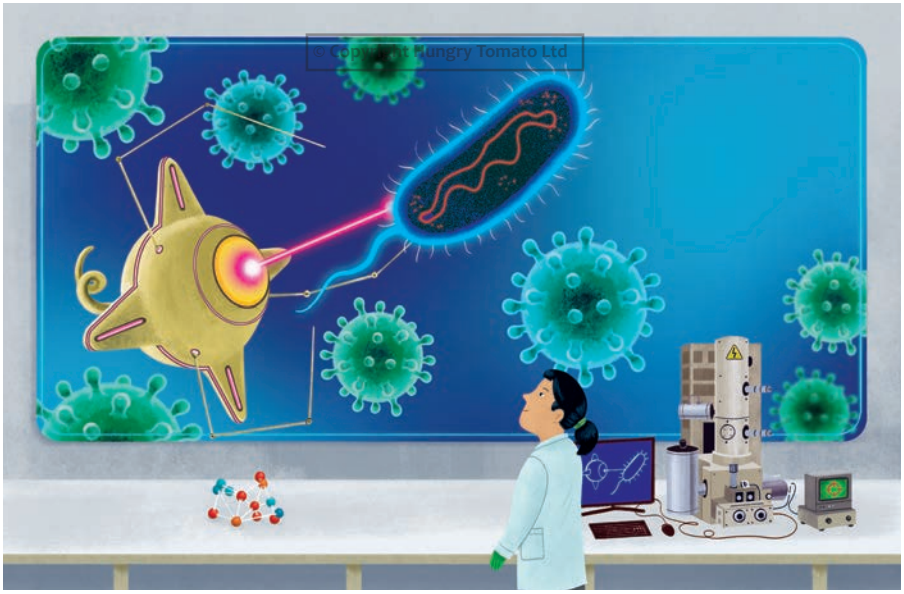
Solar panels capture sunlight and convert it into electricity. While this is a positive way of creating energy, because it uses a clean and **renewable** source that doesn't release harmful gases (compared to burning **fossil fuels**), traditional solar panels lose much of the energy they collect.

Nanomaterials like **quantum dots** and **nanowires** can improve **efficiency** by absorbing more light and turning it into power. This makes clean energy production more effective and affordable.

MANY UNKNOWNS: SCENE 13

The material for this scene can be linked to curriculum topics, including:
animals, including humans; climate change; computing; working scientifically.

Nanotechnology has great potential, but also many unknowns. Scientists are still studying the possible negative effects of using nanotechnology in different settings. Use this final scene to discuss how small-scale science could have very large impacts.



DISCUSSION PROMPTS

- **Why do scientists need to study the possible risks of nanotechnology?**
  Encourage children to think about physical factors as well as emotional, environmental, and larger-scale factors.

- **How could nanotechnology be both helpful and harmful at the same time?**
  Information overleaf

- **What do you think are some of the biggest changes nanotechnology could bring to our world?**

- **If you were a nanotechnologist, what question about nanotechnology would you want to answer?**

ACTIVITY

Corresponding activity on page 15 of the activity pack: 'Odd Bot Out' is an odd one out activity, where children must identify the nanobot that looks different from the others.

MANY UNKNOWNS: SCENE 13

RELEVANT INFORMATION

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

UNANSWERED QUESTIONS

Although nanotechnology has many promising uses, scientists are still learning about its long-term effects. For example, if nanoparticles enter the human body, they could interact with cells in unexpected ways. Similarly, if released into the **environment**, they might affect soil, water, or wildlife.

Scientists know they must fully understand the risk and benefits of this technology before using it on a big scale and out in the real world.

BALANCING BENEFITS AND RISKS

Every new technology brings both opportunities and challenges.

Medicines, plastics, and electricity all changed human life in huge ways but also introduced new risks.

With nanotechnology, researchers are carefully testing each new discovery to make sure it is safe before it is widely used.

THE POWER OF SMALL SCIENCE

Nanotechnology shows that even the tiniest things can have a massive impact.
From medical treatments to space exploration, food production to clean energy, nanotechnology has the potential to transform many parts of human life. The challenge now is to learn how to use it responsibly.

POST-READING QUESTIONS

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

- **Can nanobots change the world?**
- **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: 'Build-a-Bot' is a fun label the parts activity which encourages children to label the individual parts of a nanobot.

DISCLAIMER:

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

THE BIG QUESTIONS ANSWERED

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