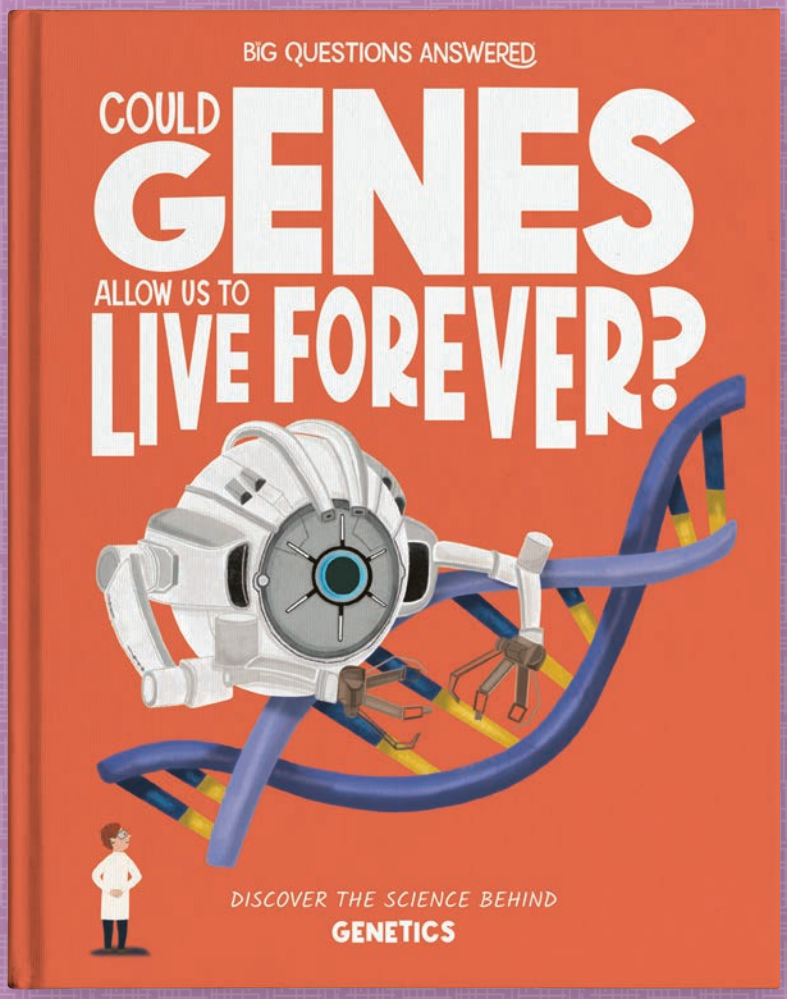
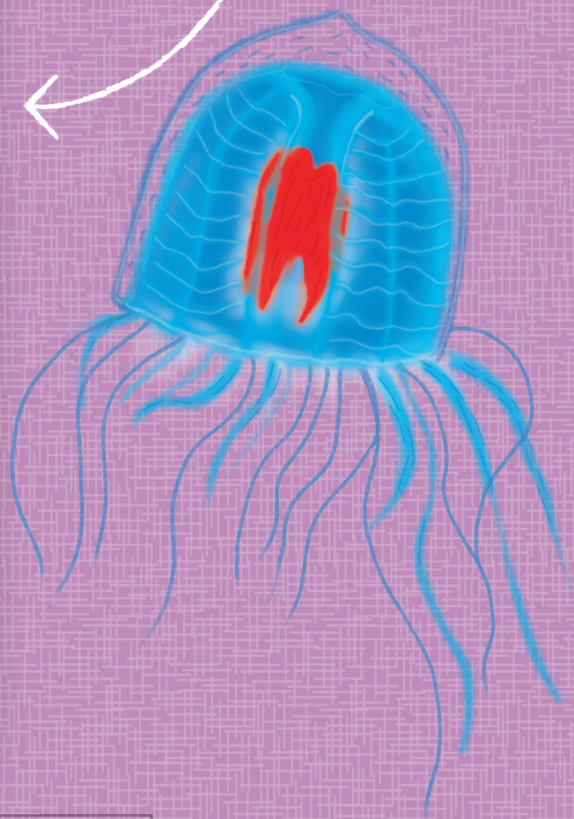
BIG QUESTIONS ANSWERED

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

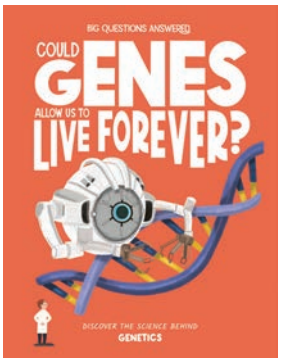
Inspire children's natural curiosity, improve literacy, and have fun learning about different sciences with The Big Questions Answered. Each book in the series is accompanied by a selection of fantastic, **FREE** downloadable resources.

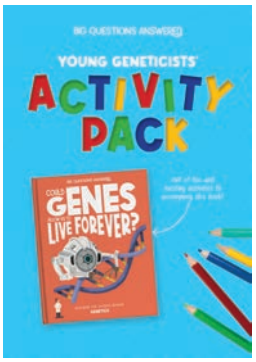
Our **Teachers' and Parents' Resources** booklets are full of ideas for discussions, extra facts, and links to hands-on activities – all great ways to help children explore each field of science and the key topics surrounding them.

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**

Could Genes Allow Us to Live Forever? book





Young Geneticists' Activity Pack

KEY CURRICULUM TOPICS

The resources related to *'Could Genes Allow Us to Live Forever?'* tie in with key curriculum topics including:

- Animals, including humans
- Climate change
- Human and physical geography
- Living things and their habitats
- Working scientifically

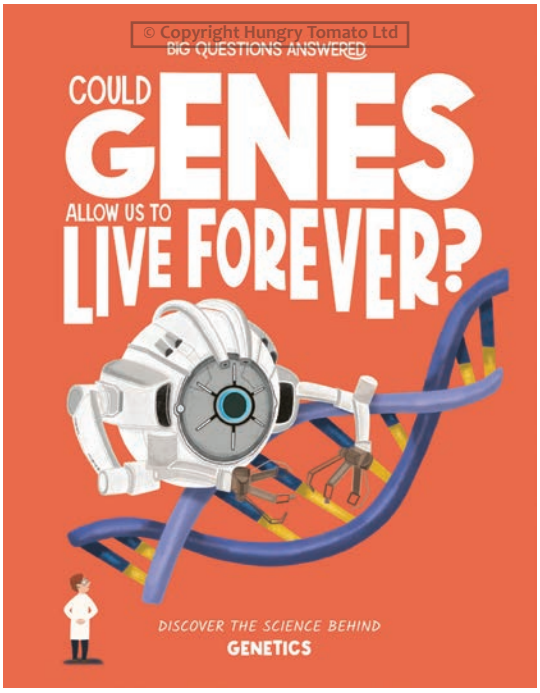
The most relevant topics are indicated throughout this guide.

COULD GENES ALLOW US TO LIVE FOREVER?

This book explores the extraordinary world of genetics. As well as covering what genes are and where they're found, this book explores the different things genes can impact and the animals that have surprising abilities because of their genes. With modern and futuristic themes, this book also covers the risks and benefits of genetic modifications, and the technology that might one day make editing genes possible.

PRE-READING QUESTIONS

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

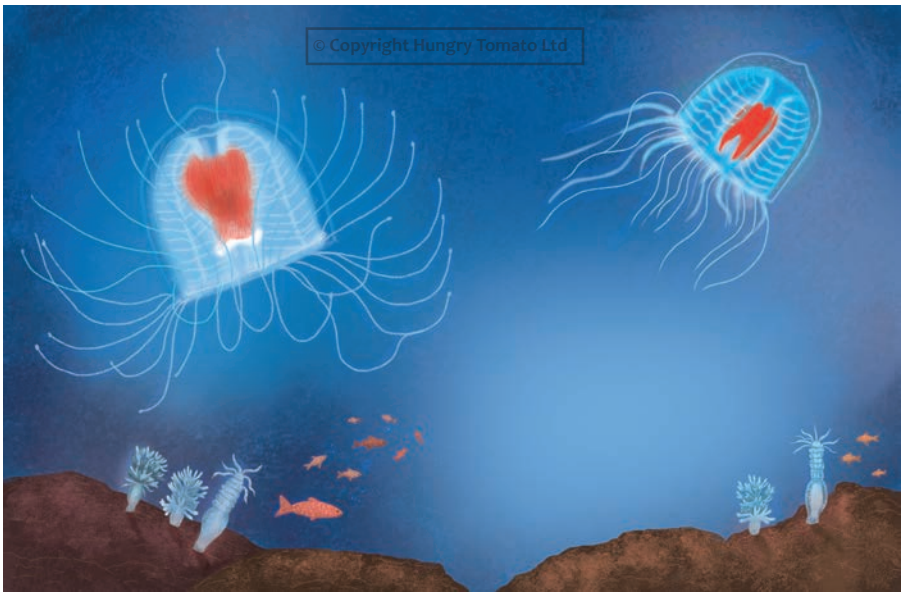


- What do you know about genes already?
- Do you think it's possible for any animal or living thing to live forever? Why or why not?
- If it were possible to live forever, would you want to? Why or why not?

THE IMMORTAL JELLYFISH: 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 the world of genetics with this deep dive into the discovery of the immortal jellyfish, whose genes allow it to turn back into a baby, so it never dies of old age! Discuss what genes are, what factors they can affect, and how geneticists study them.



DISCUSSION PROMPTS

- **What are genes?**
Information overleaf

- **Do you think this jellyfish is the only animal with this surprising ability?**
Information overleaf

- **This jellyfish has an unusual life cycle. Its young form is in this scene but might not look like you expect! Can you point it out?**
Information overleaf

- **How long do you think other types of jellyfish normally live for?**
Information overleaf

ACTIVITY

Corresponding activity on page 3 of the activity pack: 'Diary Entry' is a creative writing activity which encourages children to imagine they discovered a new type of animal that can live forever thanks to its genes, and describe it in a diary entry.

THE IMMORTAL JELLYFISH: SCENE 1

RELEVANT INFORMATION

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

GENES

Genes are like a set of **instructions** for how a living thing's body looks and works. Every living thing has its own set of genes which are completely **unique**. The only exception to this is identical twins, who also have identical genes.

They affect factors like eye colour, hair colour, height, shoe size, and whether an animal has arms or wings! Scientists now know some genes can affect how long the animal lives.

THE IMMORTAL JELLYFISH

The jellyfish in this scene are commonly called '**immortal jellyfish**'. Their scientific name is *Turritopsis dohrnii*. They originally came from the Mediterranean Sea, however they are now found in **temperate** and **tropical oceans** around the world.

This **species** of jellyfish was discovered in the 1880s, but scientists didn't discover its **immortality** until 100 years later!

It is only immortal **biologically**. It could still be killed by **environmental factors**, like being eaten by a predator.

Scientists know this ability is incredibly **rare**. They have only discovered a few other animals that are biologically immortal (although these other animals don't stay alive by turning back into a baby) including the hydra and the planarian worm.

In the scene, the pale blue and white shapes standing on the rock are some of the younger forms that the immortal jellyfish takes during its **life cycle**.

OTHER JELLYFISH

Scientists have discovered more than 2,000 species of jellyfish, but they think there are lots more out there that they still haven't discovered yet.

Some jellyfish species live for only a few hours or a few months. Some of the larger species, like the lion's mane jellyfish, can live for several years.

INSIDE ALL LIVING THINGS: SCENE 2

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

Explore the many ways that genes affect living things' bodies with this scene comparing a number of different species and their body features. Discuss how even similar features can look very different across species.

DISCUSSION PROMPTS

- **Can you name the animals and plant in this scene?**
  Information overleaf

- **Can you spot any other differences and similarities between the animals and plant in this scene?**
  Encourage children to think about shared features like eyes, nose, legs, and differences like fur, feathers, claws, and so on. There is also information overleaf.

- **Do you know what opposable thumbs are?**
  Information overleaf

- **Can you think of any other features that genes might affect?**
  Information overleaf

ACTIVITY

Corresponding activity on page 4 of the activity pack: 'Fantastic Features' is a crossword activity where children use clues to name the different body parts animals use to help them survive. They can then fill in the crossword with the answers.

INSIDE ALL LIVING THINGS: SCENE 2

RELEVANT INFORMATION

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

LIVING THINGS IN THE SCENE

The living things in the scene are crocodile; human; deer; sunflower; and golden eagle.

Lots of these living things share **features** even though they look completely different from each other. All the animals have visible **similarities** like eyes, noses, mouths, legs, and feet. They also have parts inside their bodies which are similar even though we can't see them – these include brains, hearts, and lungs.

It's because of genes that these features are **different** in size, shape, and what they're made of. For example, the crocodile's legs are short, wide, and come out of the body sideways, whereas the deer's legs are long, slim, and come out of the body vertically.

Genes are also responsible for the ways these animals are all different from each other. For example, the golden eagle has feathers all over its body while the human has lots of hair on their head and tiny hairs over the rest of their body.

Over a very long time, living things can slowly change themselves to better cope with their **habitat** and **lifestyle**. These changes also happen because of their genes.

OPPOSABLE THUMBS

Opposable thumbs can be placed opposite a finger or toe of the same hand or food. This means that the animal can pick up, grip, and hold onto things securely.

All **primates** have opposable thumbs. Primates are a group of animals including humans, apes, and monkeys.

THE IMPACT OF GENES

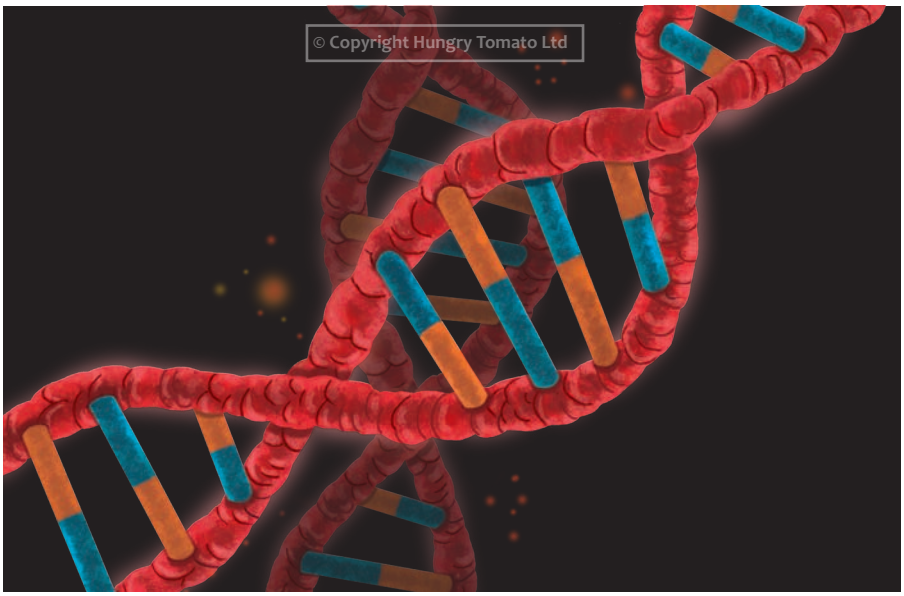
Other animal features that genes affect include **beak** or nose shape, ear shape, tail type, and number of fingers or toes, the voice or sounds that animals make, how big and strong an animal is, and many more.

Plant features that genes affect include flower colour, leaf shape and size, height of the plant, the scent that the plant gives out, the fruit or seed type, and many more.

THE SHAPE OF DNA: 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 link between genes and DNA with this scene showcasing the double helix shape of DNA. Explore how tiny these things are, where they're found in the human body, and how scientists made this incredible discovery despite its size.



DISCUSSION PROMPTS

- **What's the link between genes and DNA?**
  Information overleaf

- **Where do you think DNA is found in the human body?**
  Information overleaf

- **How do you think scientists discovered DNA?**
  Information overleaf

ACTIVITY

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

THE SHAPE OF DNA: SCENE 3

RELEVANT INFORMATION

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

DNA AND GENES

DNA and **genes** are both tiny parts in our bodies which play important parts in making us who we are. But what are they and what's the difference between them?

- Genes are tiny instructions inside all living things. They tell the body how to grow, what it looks like, and how to work.
- DNA are twisted ladder-shaped things which form genes. Each rung on the ladder helps to form the gene, like letters form a word.

DNA AND THE HUMAN BODY

DNA is found inside almost every **cell** in the human body. It's mostly found in the cell's **nucleus**. The nucleus is the part that controls the cell.

DNA is incredibly small, but because of where it's found, there is a lot of it in each body.

Scientists think the human body contains approximately 36-37 trillion cells, and each cell holds about 1 metre of DNA. This means there is an estimate 36-37 trillion kilometres of DNA hidden inside each of us!

DISCOVERING DNA

Living things have been on Earth for billions of years, but scientists only started to understand how our bodies work about 200 years ago!

In the 1860s, **Friedrich Miescher**, a chemist from Switzerland found a **substance** inside blood cells. Miescher didn't know what it was and couldn't see its shape or **structure**. Later, scientists discovered that this was DNA.

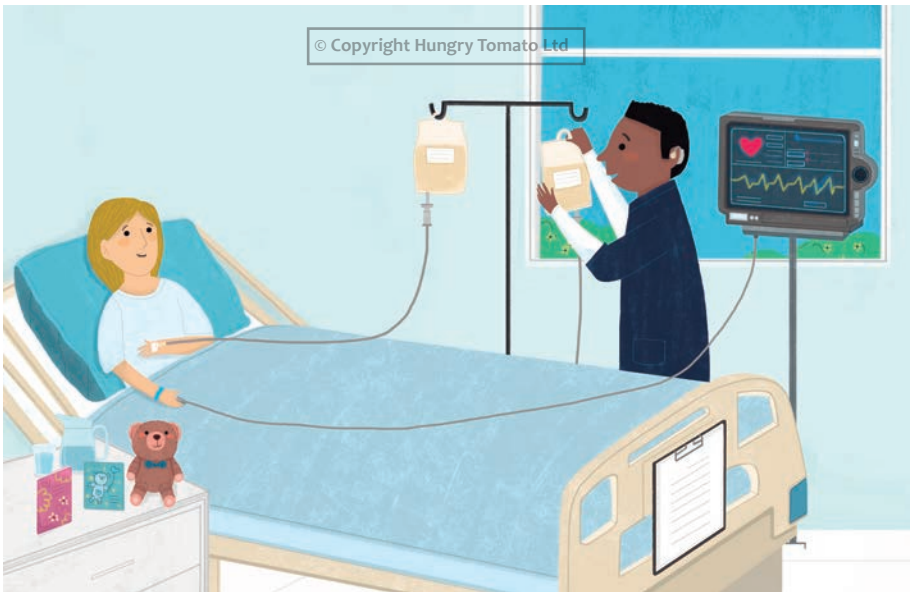
DNA is too small to be seen with normal **microscopes**. Miescher made his discovery using **chemicals** that helped him see inside cells.

Then, in the 1950s, two scientists called **James Watson** and **Francis Crick** worked out the shape of DNA. They used special **X-ray** pictures to discover that DNA is shaped like a twisted ladder. Scientists call this shape a **double helix**.

THE POWER OF MEDICINE: 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 impact that genetics is already having on healthcare and medicines with this hospital scene. Discuss how genes are passed down between generations, and how they can impact both illnesses and treatment methods.



DISCUSSION PROMPTS

- **How are genes passed down between generations?**
  Information overleaf

- **What is the link between genes and some illnesses?**
  Information overleaf

- **How do you think doctors use their understanding of genes to treat patients?**
  Information overleaf

ACTIVITY

Corresponding activity on page 6 of the activity pack: 'Hospital Room Hunt' is a spot the difference activity where there are 9 differences for children to find across 2 versions of this scene.

THE POWER OF MEDICINE: SCENE 4

RELEVANT INFORMATION

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

GENES AND DIFFERENT GENERATIONS

Genes are **passed down** from **biological** parents to their children. Each child gets half of their genes from the biological mother and half from the biological father.

That's why some people look like their parents, grandparents, or even uncles and aunts; because they share some of the same genes.

While some families share genes, some don't. That's because you don't have to share genes to be a family. Families are made in many different ways, and love is what makes them strong.

Learning about genes helps doctors understand how some **illnesses** are passed down between people in different **generations**. It also helps them treat the illnesses.

GENES AND ILLNESSES

Some **illnesses** are caused by genes that aren't formed as expected. This can happen for several reasons: a parent may pass down a specifically formed gene to a child, a gene may form in a different way from expected when a baby is growing, or a gene may change over time during someone's life.

These changes to genes may cause part of a person's body to work differently, or respond to things differently, compared to other people.

Examples of illnesses that scientists think can be linked to genes includes cystic fibrosis, sickle cell disease, and Huntington's disease.

TREATING ILLNESSES USING GENES

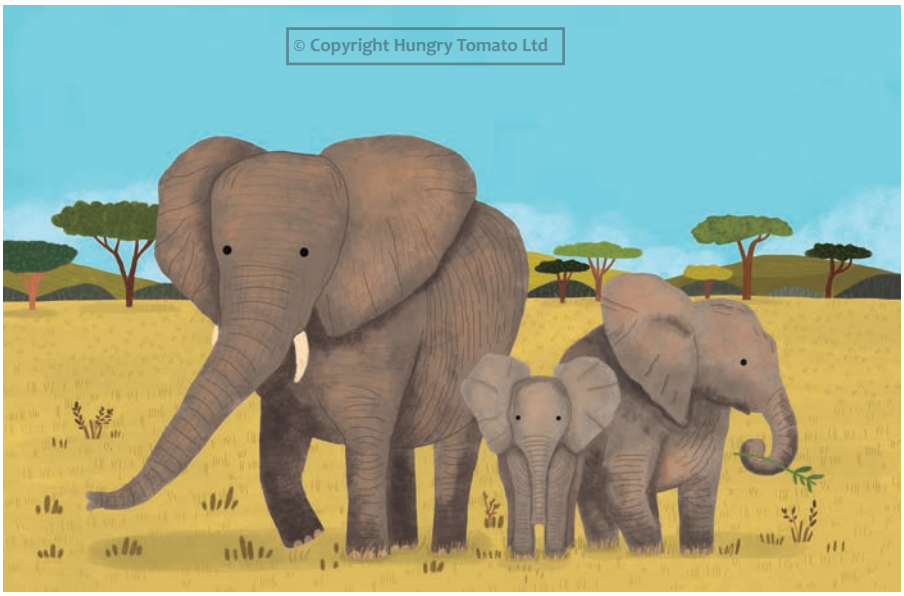
Scientists have begun **mapping** genes in more detail than ever before. They are trying to work out exactly what each gene does and affects within the human body.

This knowledge is already helping doctors understand their patients better. It helps them give **personalised** medicine and special treatment plans that work best for each individual patient.

TURNING GENES ON AND OFF: SCENE 5

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

Discover some of the amazing things geneticists have learnt by studying the genes of animals with this elephant scene. Discuss the impact that these findings may hold for human genetic studies.



DISCUSSION PROMPTS

- **Do you know what type of elephant is shown in this scene?**
  Information overleaf

- **What do elephants use their tusks for?**
  Information overleaf

- **Do you think all elephants have a genetic ability to resist cancer?**
  Information overleaf

- **Do you think scientists will ever be able to switch genes 'on' and 'off' themselves?**
  Information overleaf

ACTIVITY

Corresponding activity on page 7 of the activity pack: 'Elephant 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.

Turning genes on and off: Scene 5

Relevant information

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

Elephants in the scene

The elephants in this scene are African elephants. There are two different types of African elephants: African bush elephants and African forest elephants.

Both are **herbivores** and live in Africa, but the size of their tusks, ears, and skulls are slightly different from each other, with the forest elephants usually being slightly smaller.

Elephant tusks

Elephants use their long **tusks** to **strip bark** from trees or **dig** under the ground for food to eat. They also use them to **protect themselves** by fighting off attacking animals with them.

Sadly, thousands of elephants are killed every year by humans who want to take their tusks. This is because their tusks are made of **ivory**; a material that can be carved into precious ornaments.

Elephants and their genes

Scientists have found that there is a specific gene that elephants have that help them **resist** cancer. Because this gene used to be **inactive**, but has become active again, scientists call this the 'zombie gene'! They have found out that all elephant **species** have this gene!

Turning genes 'on' and 'off'

The process of genes turning 'on' and 'off' is called gene regulation. It happens naturally, as we know from elephants and their zombie genes.

Using **advanced technology**, scientists have found it's possible to turn genes 'on' or 'off' artificially. This process is called **gene therapy**, and it aims to fix or replace genes that aren't working as they should.

Scientists think gene therapy could be used to treat a range of illnesses, including cancer and cystic fibrosis. It doesn't work perfectly for everyone yet – scientists are still working out how to manipulate genes better and safer. But one day, this process might change lots of people's lives!

GENETICALLY MODIFYING ANIMALS: SCENE 6

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

Introduce genetic modifications with this scene which discusses the benefits modifications have had on cows, by reducing the impact of tuberculosis. Encourage children to think about and discuss the positives and negatives of genetic modifications.

DISCUSSION PROMPTS

- **How do you think scientists modified cows' genes?**
Information overleaf

- **When do you think they first made these modifications?**
Information overleaf

- **Do you think genetic modifications are good or bad? Why do you think that?**
Encourage children to discuss their opinions on this topic. There is also information overleaf about common 'for and against' arguments.

ACTIVITY

Corresponding activity on page 8 of the activity pack: 'Genetic Puzzle Pieces' is a reflective writing task where children answer questions about their opinions on a number of gene-related questions.

GENETICALLY MODIFYING ANIMALS: SCENE 6

RELEVANT INFORMATION

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

GENETIC MODIFICATIONS IN ANIMALS

Genetic modifications in animals can be made in several different ways. Scientists can make changes to something in the existing **DNA**, add new **strands** of DNA, or even take strands of DNA away. All these changes count as changing something's **genetic material**.

Making these changes allows scientists to design new **features** and **characteristics**, like disease **resistance** or faster growth. It can also increase or decrease existing features or characteristics that the animal has.

If the animal has babies after its genetic material has been changed, the updated genes then have a chance of being passed down to the next **generation**.

To help make cows more resistant to tuberculosis, scientists added a gene found in mice to the cows' bodies. This gene helps the body fight **infections**. This genetic modification was first done by scientists in China who used a type of **technology** called **CRISPR**.

THE FIRST GENETIC MODIFICATIONS

The first ever genetic modifications were carried out on **bacteria** in the 1970s. Since then, scientists have genetically modified several different types of animals and plants.

FOR AND AGAINST: GENETIC MODIFICATIONS

People often debate whether genetic modifications on animals are good or bad. Here's some of the common 'for and against' arguments:

- **For**: animals could have a **better quality of life** due to less illnesses and medicine.
- **For**: animals could **produce more meat, milk, or eggs**, helping food production.
- **For**: modified animals could help **produce proteins or substances that have medicinal benefits** for humans.

- Against: there is **still lots we don't know** about genetic modifications – they could have **unpredictable results**, like health problems or long-term effects, for animals.
- **Against**: it **doesn't seem fair, right, or natural** to change animals like this.
- **Against**: meddling with animals **could disrupt the balance of natural ecosystems and native species**.

GENETICALLY MODIFYING CROPS: SCENE 7

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

Discover how genetic modifications are being actioned in food crops. Discuss the benefits of modifications in this context and the reason they were needed in the first place, leading into a wider discussion about the impact of climate change.

DISCUSSION PROMPTS

- **How do you think scientists modify plants' and crops' genes?**
  Information overleaf

- **Why do you think these modifications were needed?**
  Information overleaf

- **Can you think of any other ways climate change is affecting the world around us?**
  Information overleaf

ACTIVITY

Corresponding activity on page 9 of the activity pack: 'Impressive Modifications' is a classic activity where children fill in the blanks in a series of sentences and facts about genes and genetic modifications.

GENETICALLY MODIFYING CROPS: SCENE 7

RELEVANT INFORMATION

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

GENETIC MODIFICATIONS IN PLANTS

Genetic modifications in plants are done in a similar way to animals – making changes to something in the existing **DNA**, adding new **strands** of DNA, or even taking strands of DNA away in order to introduce new **features** and **characteristics** or increase or decrease existing features or characteristics.

There are a few main aims with genetically modifying plants and crops. These are mainly aimed at making them more beneficial for us. These can include:

- Increasing resistance to **disease**
- Increasing resistance to **pests**
- Increasing resistance to environmental factors such as **climate change**, lack of nutrients in the soil, and/or changes to climate and weather patterns
- Making the plants grow bigger and faster
- Making the plants contain more **nutrients**
- Making the plants taste better, for example sweeter or juicier
- Making the plants last for longer before turning bad

Some people don't like the idea of eating genetically modified food because they say it's unnatural. They also worry that not enough research has been done into the long-term effects of eating this type of food.

CLIMATE CHANGE

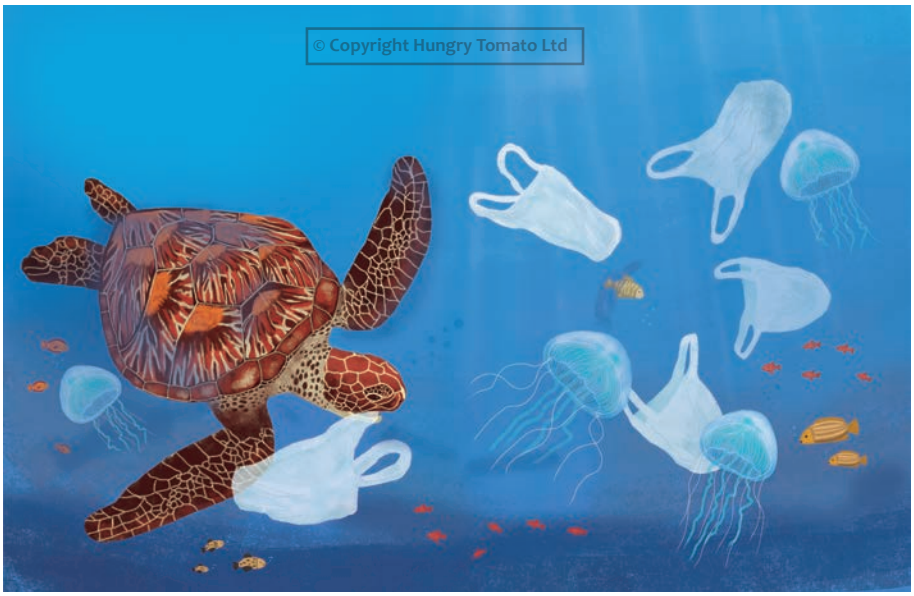
Climate change is affecting the whole world, changing the ways plants, animals, and humans interact with the habitats around them. Effects of climate change include:

- **More frequent and extreme weather** events, like hurricanes and flooding.
- **More extreme temperatures** with hot places getting hotter and drier, leading to droughts and increased wildfires.
- **Loss of habitats** for animals, and loss of places for humans to live, sometimes leading to whole **species** being put at risk of **extinction**.
- **Changes to the food chain**, with some animals struggling to cope with these changes.
- **Animals moving to different locations**, which can lead to them **spreading diseases** to new places.

PLASTIC-EATING BACTERIA: SCENE 8

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

Discover how scientists think genetically modifying bacteria can help the natural world! Discuss why plastic is so bad for the environment, and other ways we can all help to reduce its impact on the world around us.



DISCUSSION PROMPTS

- **Why is plastic bad for the environment?**
Information overleaf

- **Can you think of any ways we can help reduce plastic in the environment?**
Information overleaf

- **How else can we look after the natural world?**
Encourage children to talk about things like turning off lights and electrical items when not in use, walking or cycling instead of driving, and so on. There is also information overleaf.

ACTIVITY

Corresponding activity on pages 10-11 of the activity pack: 'Super-Bacteria' is a drawing activity that encourages children to get creative and design their own plastic-eating bacteria. Then, they can fill in a comic strip showing the bacteria saving the ocean.

PLASTIC-EATING BACTERIA: SCENE 8

RELEVANT INFORMATION

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

PLASTIC AND THE ENVIRONMENT

Plastic is really bad for the **environment** because it never really goes away and ends up in animal **habitats**. Many sea creatures or seabirds mistake plastic for food. If they eat it, it can lead to **injury**, **poisoning**, or **starvation**. They can also get tangled up and trapped inside plastic waste.

It's not just plastic bags that are the problem. Hard pieces of plastic can get broken up into tiny pieces, but even those tiny pieces can cause a lot of damage if eaten by animals, or if they get **embedded** in animals' bodies.

The World Wildlife Fund (WWF) estimates that there could be more plastic in the ocean than fish by 2050 if we don't change our plastic usage! They also think half of all **marine** turtles have eaten plastic and 90% of seabirds have plastic in their stomachs!

REDUCING PLASTIC

The best thing we could do is stop using plastic.

Using items made from **recycled**, natural materials instead is much more friendly for the natural world. Using your own reusable water bottle, shopping bags, and cutlery on a daily basis rather than always buying and throwing away plastic can make a big difference if we all start doing it.

LOOKING AFTER THE NATURAL WORLD

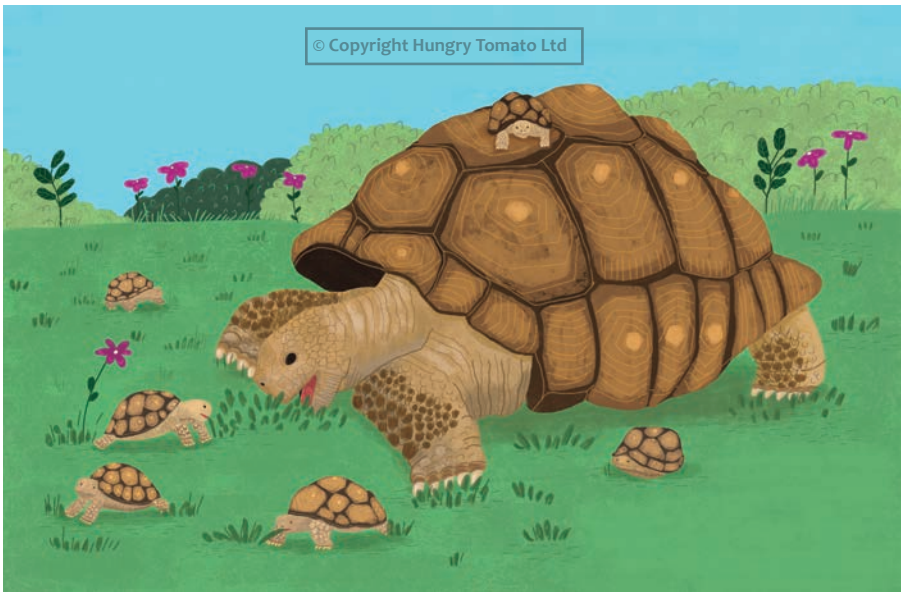
Other ways we can help look after our planet include:

- Putting things in the correct bins instead of littering.
- Avoid using harmful **chemicals** in farming and gardening.
- Not disturbing wild animals or their homes.
- Learning about **endangered** animals and how to protect them.
- Planting more trees and plants.
- Using less water.
- Turning light and electrical items off when not in use.
- Walking, cycling, or using public transport instead of cars.
- Talking about the dangers to the planet and spreading awareness to others.

LONG-LIVING GIANT LAND TORTOISES: SCENE 9

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

Introduce some of the world's longest living animals, with this scene which focuses on giant land tortoises. Explore the role their genes, as well as other factors, play in them being long-living creatures.



DISCUSSION PROMPTS

- **Where do giant land tortoises live?**
  Information overleaf

- **How big do these tortoises grow to be?**
  Information overleaf

- **Do you think any other factors help these tortoises live really long lives?**

Encourage children to discuss other factors that affect longevity, such as healthy diet, plenty of sleep, not many predators, and so on. There is also information overleaf.

ACTIVITY

Corresponding activity on page 12 of the activity pack: 'Lost in the Grass' is a classic line maze where children have to complete the maze to help the baby land tortoise find its way back to its parent.

LONG-LIVING GIANT LAND TORTOISES: SCENE 9

RELEVANT INFORMATION

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

GIANT LAND TORTOISES

Giant land tortoises are mainly found living in **remote tropical islands**, such as the Galápagos Islands off the coast of South America.

There are lots of **subspecies** of giant tortoises and they all look a little bit different, as they have each **adapted** to the conditions of the islands where they live.

The biggest giant tortoises are Galápagos giant tortoises, which are the ones pictured in this scene. They can weigh over 300 kilograms (660 lbs) and grow to be 1.3 metres (4 feet) or longer!

The second-biggest giant land tortoises are Aldabra giant tortoises, which are only slightly smaller than Galápagos giant tortoises.

Scientists think that these tortoises grow to be so big because they live on islands where there is a limited number of animals. They don't have to worry about, or compete with **predators** for food, meaning they can grow much bigger than other sorts of tortoises.

LIVING LONG LIVES

As we have read about in this scene, giant land tortoises can live very long lives. Scientists have discovered that these animals have **genetic characteristics** that enhance **DNA repair** and **immune responses**, which means they age slower and are good at fighting off illness.

However, scientists think that genes only tell part of the story when it comes to these tortoises living for a long time.

Giant land tortoises also have very slow **metabolisms**. This means that they burn **energy** really slowly. Their hearts also beat really slowly.

They seem to have genes which **suppress** cancer, a **disease** which affects other animals and humans much more seriously.

All of these other factors may have an effect on tortoises living very long lives. The genes are important, but they are not the only reason for tortoises growing so old!

DNA-REPAIRING GENES - NAKED MOLE-RATS: SCENE 10

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

Introduce another of the world's impressive long living animals, with this scene which focuses on naked mole-rats. Compare this species with other rats, considering the impact its genes have on its longevity as well as its habitat.

DISCUSSION PROMPTS

- **Can you spot any similarities and differences between the naked mole-rats in this scene and other types of rats?**
Encourage children to point out features such as the giant teeth, claws, lack of fur, and so on. There is also information overleaf.

- **Where do naked mole-rats live? What do you think their habitat is like based on this scene?**
Information overleaf

- **Can you think of any other types of habitats?**
Information overleaf

ACTIVITY

Corresponding activity on page 13 of the activity pack: 'Safety in Numbers' is a fun maze activity for children to help the naked mole-rat find its way through the maze to reach the safety of its pack.

DNA-REPAIRING GENES - NAKED MOLE RATS: SCENE 10

RELEVANT INFORMATION

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

DIFFERENT TYPES OF RATS

There are more than 60 **species** of rat in the world. Yet despite their name, naked mole-rats aren't actually rats! They are more closely related to porcupines, chinchillas, or guinea pigs.

Similarities between rats and naked mole-rats include:

- Have strong teeth for gnawing through food
- Similar body size and shape
- Similar body features like long tails.

Differences between rats and naked mole-rats include:

- Naked mole-rats live in big groups whereas other rats live alone.
- Naked mole-rats have very little hair whereas other rats' bodies are covered in fur.
- Naked mole-rats can live over 30 years whereas other rats usually live 3-5 years.
- Naked mole-rats have in huge front teeth that stick out of their mouths whereas other rats have much smaller teeth that aren't as noticeable.

NAKED MOLE RATS

Naked mole-rats are **native** to the Horn of Africa. They live in **underground burrows** in dry **habitats** like savannahs, and shrublands.

Because they spend almost all their time underground, they have **adapted** to the constant darkness by relying on their touch, hearing, and smell for **navigating**.

OTHER TYPES OF HABITATS

Deserts, savannahs, and shrublands are examples of habitats. Some examples of other habitats include deserts, swamps, rainforests, temperate forests, and grasslands.

Each type of habitat has different **weather** and **climate** conditions, and physical features, as well as different types of plants and animals living there.

REPAIRING CELLS WITH NANOBOTS: 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 some of the high-tech machines scientists are developing to help repair and protect human DNA. Discuss how tiny nanobots are, how they are made, and the potential benefits and risks of using nanotechnology inside the body.

DISCUSSION PROMPTS

- **How tiny do you think these robots are?**
Information overleaf

- **What do you think are the potential risks and benefits of using nanotechnology inside the body?**
Encourage children to consider factors such as cost and danger, as well as the potential to extend lives and make people healthier. There is also information overleaf.

- **How else do you think these tiny robots could be used?**
Information overleaf

ACTIVITY

Corresponding activity on page 14 of the activity pack: 'The Future of Genetics' is a classic word search activity, using lots of great words related to genes and genetics to get children familiar with the language of this science.

REPAIRING CELLS WITH NANOBOTS: SCENE 11

RELEVANT INFORMATION

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

NANOBOTS

Nanobots are **robots** that are built on the **nanoscale**.

The nanoscale is the way scientists measure things that are incredibly small. A sheet of paper is about 100,000 nanometres thick!

Things that are nano-sized are so tiny they can only be viewed with incredibly strong **microscopes**. Because of their extreme size, they may be used in many different places.

Scientists and **engineers** are designing, creating, and training these robots to repair **cells**, deliver medicine to cells in need, and even perform **surgeries** inside the body.

NANOTECHNOLOGY AND THE BODY

There are lots of potential benefits and risks for using nanobots inside the body. Here are a few common 'for and against' arguments:

- For: it could be a **more effective way of treating illnesses** as the nanobots can target specific parts of the body.
- For: it could be **better for patients as it's less invasive** than big surgeries.
- For: it could **monitor the body, providing real-time data and earlier diagnoses**.

- Against: **we don't know the long-term risks**, and it will take a long time and lots of money to fully understand the risks of using nanobots inside the body.
- Against: it **could be really expensive**, meaning some people can't afford this kind
- of treatment.
- Against: people could take advantage of this technology and **use it for the wrong reasons** instead of helping people.

OTHER USES OF NANOBOTS

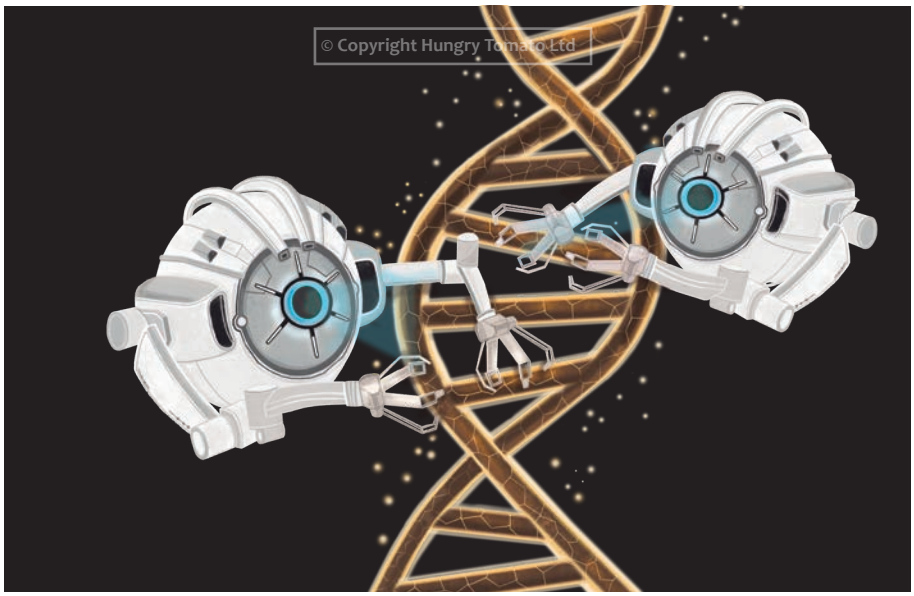
Nanobots could be used in other ways, including:

- Cleaning **bacteria**, **viruses**, and **pollution** from water.
- Repairing the **ozone layer** in Earth's **atmosphere**.
- Repairing spacecraft during missions to outer space.

THE FUTURE OF DNA: SCENE 12

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

Consider how genetics and technology will interact in the future with this hypothetical scene which shows robots editing DNA. Discuss why some scientists think humans living forever is impossible and what it would be like to live for more than 150 years.



DISCUSSION PROMPTS

- **Why do some scientists think humans living past 150 years old will never happen?**
  Information overleaf

- **What would it be like to live for more than 150 years? What would the world be like if people lived to be that age?**
  Encourage children to consider factors such as housing and feeding the population, people needing to work longer to maintain their income for longer, and so on. There is also information overleaf.

- **Do you think scientists will one day find a way to make this happen? Why or why not?**

ACTIVITY

Corresponding activity on page 15 of the activity pack: 'Draw Your Own DNA-Editing Robot' is a creative drawing activity where children design a new type of robot that can edit DNA and draw a scene to show off their creation.

THE FUTURE OF DNA: SCENE 12

RELEVANT INFORMATION

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

LIVING PAST 150

Some scientists believe that humans will never be able to live past 150. They think the maximum **lifespan** for humans is 115 to 125 years old.

The reason they give for this is that **genetic modification technology** couldn't keep up with the rate that humans' **cells** become damaged. As we age, our bodies take longer to heal from **stress**. Some scientists think **medical** or genetic intervention would never be enough to combat this.

However, there are lots of things science and technology has allowed us to do today that people in the past would never have believed possible. Science is always pushing the limits of what is possible!

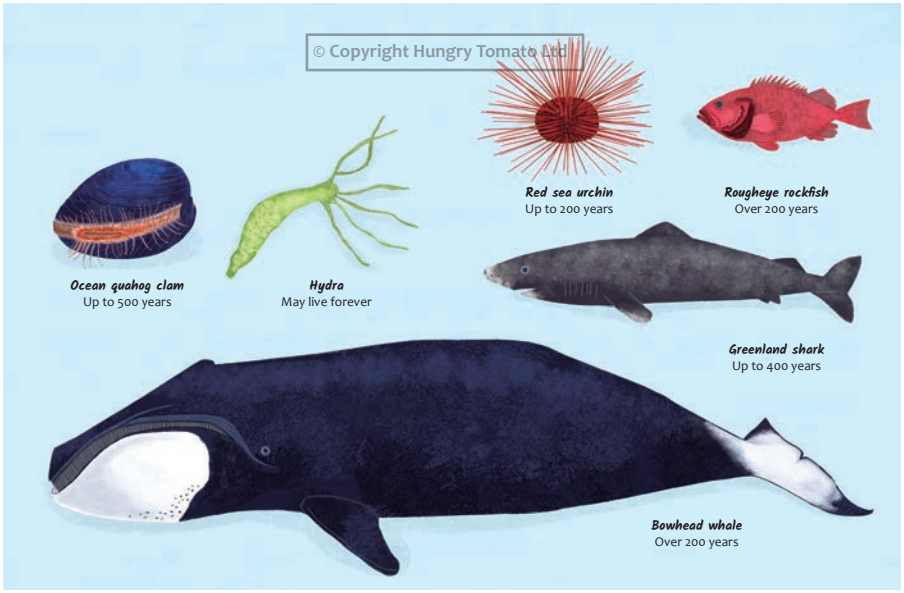
If people lived to be 150 or older, there would be lots more things to consider, including:

- With lots more people in the world, there would be **higher demand for places to live**.
- With lots more people in the world, there would be **higher demand for food**, so growing enough food for everyone would get much harder.
- With lots more people in the world, there would be **higher demand for electricity and energy**. We would need to use clean, **green energy** sources to avoid putting more strain on the **environment**.
- With people living longer, there could be **more need for medicine, doctors, and help at home** as people cope with older, more frail bodies for longer.
- With people living longer, we would all **need to work for more years** to have enough money to keep living, which would change job prospects and the working world.

ANIMALS WITH RECORD-BREAKING GENES: SCENE 13

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

Consider the similarities and differences between some of the longest-living animals on Earth with this conclusion scene which shows an impressive selection. Explore the other factors that may play a part in these animals' abilities.



DISCUSSION PROMPTS

- **What similarities and differences can you spot between the animals in this scene?**
Encourage children to think about physical factors as well as habitat factors.

- **Do you think any of these similarities might play a part in the animals living for a long time?**
Information overleaf

- **Do you think it's possible that scientists might find more immortal animals in the future? Why or why not?**
Information overleaf

ACTIVITY

Corresponding activity on page 16 of the activity pack: 'Long-Living Animals' is a cut and stick task where children match up the images of long-living animals with their lifespans. They then put them in order!

Animals With Record-Breaking Genes: Scene 13

Relevant Information

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

Long-Living Animals

While there are visual similarities between some of the animals in the scene, there are no visual similarities that they all share. Some of them have **unique** features and they all vary in size too. *Note: the animals in the scene aren't to scale with each other.*

What is similar about all the animals in this scene is that they live in **aquatic habitats**.

The reason these animals live so long could be partly to do with their **genes** and partly to do with their **lifestyle** and habitats.

Scientists have found that many animals that live in cold habitats live longer than those in hot habitats. This is because they usually have slower **metabolisms**. Big animals also tend to have slower metabolisms. Many of the animals in this scene match one or more of these criteria.

There is also the fact that animals who live in deeper water are protected from changing temperatures, extreme weather, and interference from humans – all things which impact **species** that live in shallower water.

Water is also really supportive and makes bodies seem lighter. This makes it easier for water-living animals to move around and puts less **stress** and **pressure** on their bodies compared to land-living animals.

Scientists still have a lot to learn about long animal **lifespans**, but many think it's both genes and lifestyle which have an impact.

Discovering New Species

Despite all the amazing things we do know about the living things on Earth, much of our planet – which is ocean – remains unexplored. So, it's not surprising scientists think there are lots more **species** in the world that they haven't discovered yet.

In fact, they estimate that they discover around 18,000 new species every year – who knows what they will discover next!

POST-READING QUESTIONS

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

- **Could genes allow us to live forever?**
- **Did anything else in the book surprise you?**
- **What's the coolest thing you've learnt from this book?**

ACTIVITY

Corresponding activity on page 17 of the activity pack: 'Write Your Own Genetics Story' is a creative writing activity which encourages children to write a story about genetics, using three key prompt words.

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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