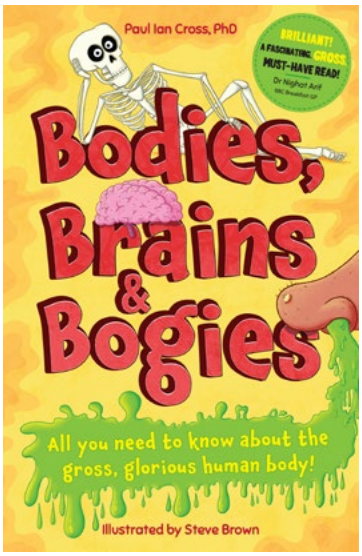
BODIES, BRAINS AND BOGIES

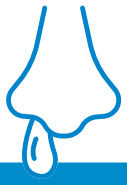
Pupil activity sheet

CENTRE *for* INDUSTRY EDUCATION COLLABORATION

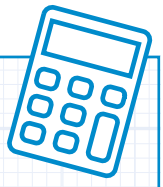
This is one of a series of six activity sheets to use alongside the books which have been shortlisted for the Royal Society Young People's Book Prize 2023.



This book celebrates everything that is weird and wonderful about our bodies from brain biology to toenail trivia. Fascinating facts, informative illustrations, and detailed diagrams; a fun and accessible way to learn all about our brilliant bodies in *Bodies, Brains & Bogies* written by Paul Ian Cross PhD, and illustrated by Steve Brown.



> "Even though our bodies are weird and gross, they're also unique. There's no one else like you in the entire world. As a matter of fact, there's no one like you in the ENTIRE UNIVERSE."
>
> ***Bodies, Brains & Bogies***

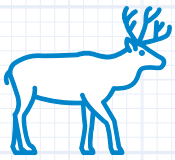


Mathematics challenge

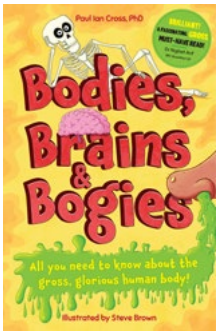
Humans belong to a class of animals called vertebrates meaning we have a backbone. Animals with bones inside their body (known as an endoskeleton) make up just 3% of all the animals on Earth. The other 97% are invertebrates, like insects, which have a tough outer shell called an exoskeleton.

Limb structure varies greatly in shape, size, and function across the animal kingdom. Use books and online research to find out how many bones are in the top or front limbs and bone structures of different vertebrates. Here are some UK vertebrates to get you started:

Once you have collected your animal bone data, can you put the animals in order based on the number of bones they have? Do you notice any patterns? Does the size of the animal make a difference to how many bones they have? How do land animals compare to animals that live in the water, or animals that fly? Did you discover anything surprising?



Roe deer leg	Pipistrelle bat wing	Basking shark pectoral fin
Sparrow wing	Harbour seal pectoral flipper	Red squirrel arm
Orca whale pectoral fin	Common frog leg	European otter arm



BODIES, BRAINS AND BOGIES

Pupil activity sheet (continued)

Thumb dexterity

You have been challenged to investigate whose thumbs are better adapted to text typing by taking part in a speed trial. Ask your friends and family members to get involved. The more data you collect, the better your results will be.

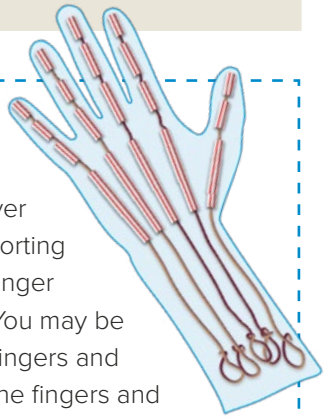
Use the same short sentence then time how long people take to type it into a text message using a phone. Make sure you test people of different ages and across different generations, like siblings, parents, and grandparents.

Alternatively, you could set up your own investigation and give people one minute of typing time to see how many times they can write your 10-word sentence and calculate their words per minute. Compare your results with another round of testing, this time asking your test subject to type the words out on a desktop or laptop keyboard. How do the generations perform differently?

Wings and things

We use our hands and fingers to help with lots of daily tasks but there are plenty of animals that get by in life without the benefit of these body parts. Where we have arms and hands, other creatures have wings, fins, flippers, extra legs, or tentacles. Use library books and internet research to find out about the many different limb arrangements and bone structures in the animal kingdom and how they are used.

Helpful hands



Have you ever taken a moment to consider how human hands work? Underneath the protective layer of skin is a network of veins and arteries for transporting blood and a structure of 27 bones: 14 phalanges (finger bones) and 8 metacarpals (the palm of the hand). You may be shocked to find that the muscles which move the fingers and thumb are in the forearm. They are connected to the fingers and thumb by stretchy tendons. You can have a go at making a moving hand model which shows how the tendons control the movement of fingers. There are plenty of online tutorials you can look for.

Scientist profile

Meet Dr Paul Ian Cross. He is a scientist, a science communicator, and a writer who enjoys making science, technology, engineering, and maths (STEM) accessible and interesting for pupils and adults.

In his work as a scientist, Paul is a medical researcher specialising in vaccine development. In addition to his work in the lab, he shares science facts on social media where he communicates his passion for biology, health, medicine, and nature.

Paul's scientific curiosity doesn't end there, he's also interested in technology, environmental sustainability, climate change, and the exploration of the universe, all of which find their way into his science fiction stories.

A scientist first, then a successful author; who says you can only have one passion in life?

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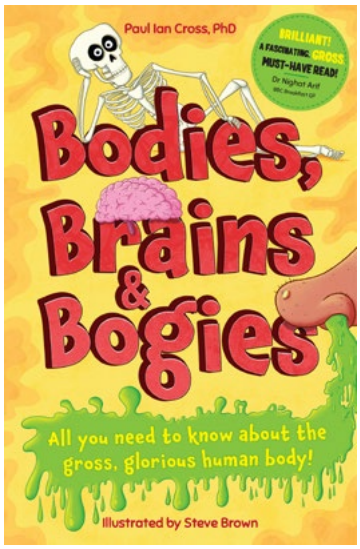

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How useful are our limbs?

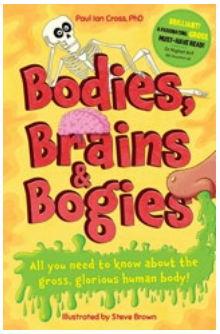
Ask your class what they've used their hands for in the last 24 hours. No doubt a surprising array of activities like brushing teeth, texting, tying shoelaces, and online gaming; but do they know the backs of their hands as well as the old idiom would suggest?

Placing their non-dominant hand palm-down beneath a desk, and a piece of paper on the desk above the hand, pupils draw ten dots to show where they think their fingertips end and where the knuckles are. Connecting the five knuckle dots and drawing lines connecting each knuckle to the fingertip, ask pupils to compare this drawing to their own hand. Is it accurate?

It is likely very different from their hand. People often draw their hands much wider and fingers much shorter, showing that our brains are interpreting our bodies differently to how they actually are. This is important to remember when it comes to how we feel about our bodies. The 'Body Beautiful' chapter has some great tips for understanding our differences and staying body positive.

Scan the QR code to find out about limb research by watching this two minute video segment (starting at 1:44:52), from the Royal Society Summer Exhibition 2022.

Find out more about the research team involved.



BODIES, BRAINS & BOGIES

Teacher activity sheet (continued)

How useful is my thumb?

In the Awesome Anatomy chapter, we learn just how important thumbs are to the evolutionary success story of humans, but how much of a difference do they make?

Challenge pupils to pick as many items up (eg beads) with one hand as possible using their whole hand. Repeat the task, this time without using their thumb. Pupils can make predictions about what they think might happen. Our thumbs have two bones whilst our fingers have three. Does this information alter pupils' predictions? Can you pick up the same number of items? Why? Were different strategies needed?

Consider repeating this activity isolating the pinkie finger or index finger. Do they have different effects? Do you see the same results comparing dominant and non-dominant hands?

Thumb dexterity

Over many generations, humans have evolved to use their thumbs for gripping and using tools, developing hand-eye coordination, and fine tuning our problem-solving skills, all of which have strengthened our thumb muscles helping to make us the dominant species we are today.

Hand-held devices like smart phones, tablet PCs, and gaming controls are fairly recent inventions and us humans, and our thumbs, have embraced these new technologies for gaming, messaging, and more. Scientists have noticed that younger generations who have grown up with smart phones seem to use their thumbs to type, whereas older generations, who have adapted to hand-held devices tend to type with their fingers. So do pupils have more flexible thumbs?

Challenge pupils to find out if their thumbs are well adapted to text typing by challenging them to a speed trial. Agree on a sentence about 10 words long and time how long it takes them to type it into a text message using a hand-held device. Could pupils involve children in other year groups and the adults in school to increase their data set and compare across a larger age-range? Pupils can record the results and use them to create a graph to show patterns and trends.

Career links

- **Biologists**
  study living things like plants and animals. An anatomist is a special type of biologist who studies humans and other animals to learn about the structures of our bodies and how our organs are organised inside us.
- **Neuroscientists**
  work to understand how our brains and nervous system work and develop over time. They study how we form ideas and make decisions, and how to fix our brains if things go wrong.
- **Physiotherapists**
  help people affected by physical injury, illness or disability through movement and exercise. They can teach us more about how our muscles and bones work together and give us advice on how we sit and stand, and how we can prepare for and recover from sports and exercise. Some physiotherapists work in healthcare and others work with athletes and sports people to keep them in peak physical condition for their jobs.

GERMS

Pupil activity sheet

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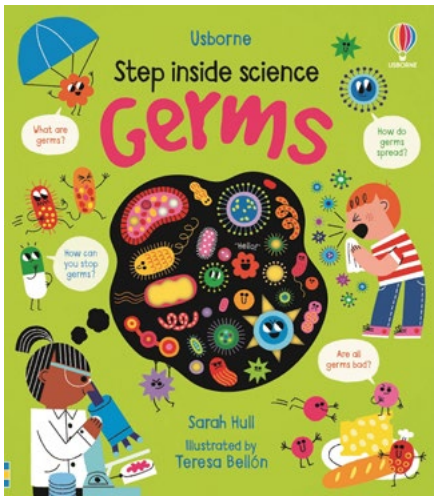


"Most germs are HARMLESS, which is lucky, because they really ARE everywhere! There are MILLIONS and BILLIONS and TRILLIONS of germs on planet Earth."

Germs

We hear a lot about germs but what are they? Delve into the microscopic world of viruses and bacteria to find out how they spread and some of the useful things they do for us in Step inside science: Germs. Written by Sarah Hull and Illustrated by Teresa Bellón.

Words of wisdom

'Germs' is a word scientists use when talking about a group of microscopic organisms. Here are some other scientific words and phrases used in the book. They might be completely new to you, or maybe you just need to improve your understanding of how they are used by scientists. When we feel poorly, we often use phrases like, 'It hurts', 'Tummy bug', or 'Feeling sick', but scientists use specific terms to talk about illness and how we get better.

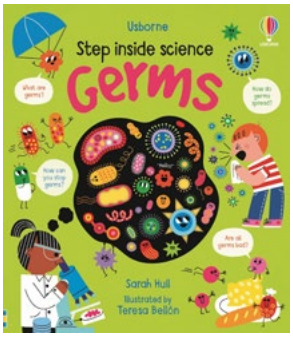
Working with a partner, pick out the terms you understand fully and have a go at using them in a sentence. Listen carefully to each other to check you are using the terms correctly. Can you use two or more words in the one sentence? Use a dictionary or search online to find the meaning of those terms you are less sure of. When you can explain the terms to someone else you are ready to use them in your investigations.

virus	bacteria	infection
diseases	antibodies	white blood cells
antibiotics	vaccine	microscopic

Mathematics challenge

Once you have carried out your filtration investigation, you will have a set of results showing how quickly different materials were able to filter your mixture. Can you create a bar chart or other mathematical way of sharing your results with others?

Did you come up with an effective way to measure how clear the filtered water was? Perhaps you used a 1-10 scale and ranked each material, or maybe you used data loggers to measure how much light could pass through the mixture. With two sets of numerical data, you can create a line graph to see if there is any link between the time taken to filter, and how clear the water is at the end.

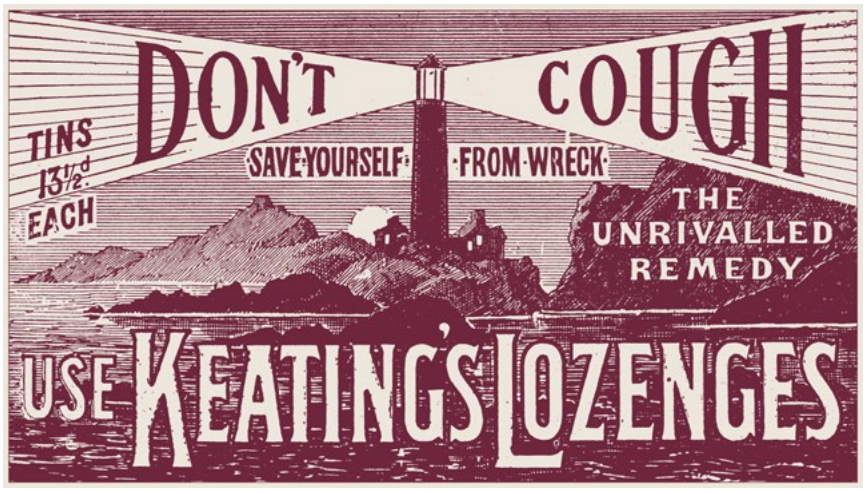


GERMS

Pupil activity sheet (continued)

Making marvellous medicines

When a doctor prescribes you a medicine, how do they know it will help you get better? We trust medical professionals to provide drugs they know are safe for us to use but who is responsible for making sure? Before treatments can be recommended by our doctors, they must be tested in clinical trials (carefully monitored tests) to see what effect they have on how volunteers respond. Research online to find out how medicines are discovered, tested, and made safe for patients. Have a group discussion to share what you have found out. Was this something you had thought about before? Did anything surprise you? Do you feel reassured by what you have discovered?



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Marketing medicine

When your cough syrup recipe is finalised, take another look at the medicine packaging your teacher shared with you and search online for examples of cough syrup adverts. How do they try to sell them to customers? What words do they use? What images do they show? How do they use colours? Work with a group to come up with an advertising poster or video which you could use to persuade people to buy your cough syrup. A script or storyboard might come in useful.

Scientist profile

Meet Professor Dame Sarah Gilbert, a professor of vaccinology at the University of Oxford. 'ology' at the end of a word refers to a type of science. Vaccinology is the science of developing new vaccines to help prevent major global infectious diseases.

In 2020, Sarah led a team of people who helped create the Oxford / Astra Zeneca COVID-19 vaccine in record time and helped save millions of lives around the world. In recognition of this achievement, she was made a Dame, a special award, given by Queen Elizabeth II, for her services to science and public health.

Recognising her vital work during the pandemic, toy company Mattel even created a Barbie doll in her image which she hopes will inspire more young girls to pursue a career in science. Sarah's Barbie is one of six, celebrating other women involved in the coronavirus response, including doctors, nurses, and medical researchers.

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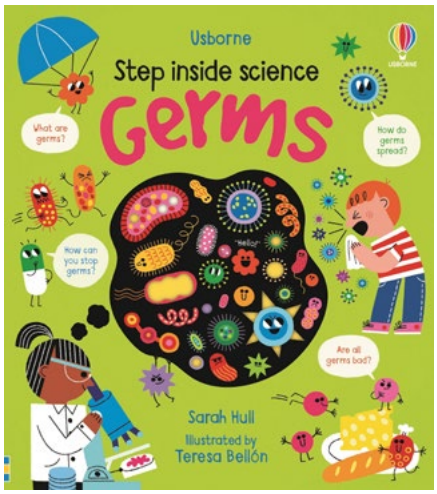

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How can some germs make us poorly and some germs make us better?

Rest, fluids, and over-the-counter painkillers are some of the recommended remedies for common viral infections like coughs and colds. To treat infections caused by bacteria, like strep throat and scarlet fever, we may need a doctor to prescribe antibiotics, drugs used to kill the living bacteria that cause the problem. But where do antibiotics come from?

Take your class on a journey through the medicine development process from growing microbes to tablet design.

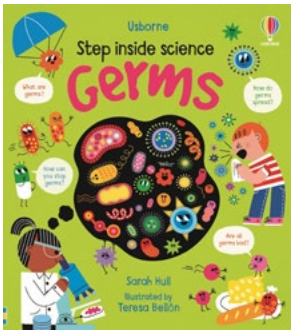
Investigating food sources for microbes

Have the pupils take on the role of expert scientists working on behalf of a pharmaceutical company, or real-life microbiologist, to research and design a new cough syrup. Begin by exploring a range of empty and clean medicine packaging where you will discover that the recipe for medicines contains an *active ingredient*; the part that helps people feel better.

Some microbes are good for us and produce substances that kill other microbes which are bad for us. The substance they create can be used as the active ingredient in medicines. Replicate this stage of medicine design by challenging pupils to investigate a range of suitable food sources for growing a good, classroom-safe, microbe they may be familiar with; yeast. The aim is to find the best food source for growing the microbe.

Pupils mix yeast inside small plastic bottles with different food sources (flour, salt, sugar, and lemon juice), add hot water (approx. 50°C) and see which food source helps the yeast grow best.

Growing yeast releases carbon dioxide (just as we do). Capture this in balloons so pupils can see if their food source has been effective.



GERMS

Teacher activity sheet (continued)

Filtering the active ingredient

A mixture of flour and water creates a classroom-safe replica of your food source investigation for stage two of medicine development, filtering. Ask pupils to consider how they will separate the solid waste (flour) from the liquid (water) containing the active ingredient. Which materials might make a good filter? How will they test them? When concluding which filter material is best, pupils might consider how long the filtering process takes and how much of the flour is removed from their sample.

Cough syrup viscosity

The final stage is recipe design. Challenge pupils to develop a recipe which could be mixed with the active ingredient to make the final product. Consistency is important; the cough syrup needs to be runny enough to pour from a bottle but thick enough to coat a patient's throat. Pupils could explore a range of different liquids and devise a way to measure their viscosity. How can they test runniness? What equipment do they plan to use? What consistency will they aim for? Mixing liquid glucose, glycerine, and water in various ratios, ask your class to find the ideal recipe.

Taking it further

Scan the QR code to access the free resource Cough Syrup which includes detailed planning and pupil sheets to support these activities.

And if your class has enjoyed exploring the medicine development process, the free resource Medicine for Pets has further investigations into medicine development, designing tablet shapes, creating tablet coatings and more.

Career links

- **Microbiologists** study microorganisms (microbes) so they can understand how they affect our lives and how they can be useful to us. Their work helps to solve problems affecting our health, the environment, the climate, and the food we eat.
- **Virologists** are a special type of microbiologist who study illnesses caused by viruses like the common cold, influenza (the flu), and COVID-19. As well as diagnosing and researching treatments for viral infections, they may track the cause and spread of viruses and research potential vaccines. Bacteriologists do a similar job for illnesses caused by bacteria.
- **Food scientists** make sure that the food and drinks we consume meet our country's safety and quality standards. They study the properties of food such as colour, flavour, texture, and nutritional value. It's important that they know about different types of mould, yeast, and bacteria that could be harmful.

LIVE LIKE A HUNTER GATHERER

Pupil activity sheet

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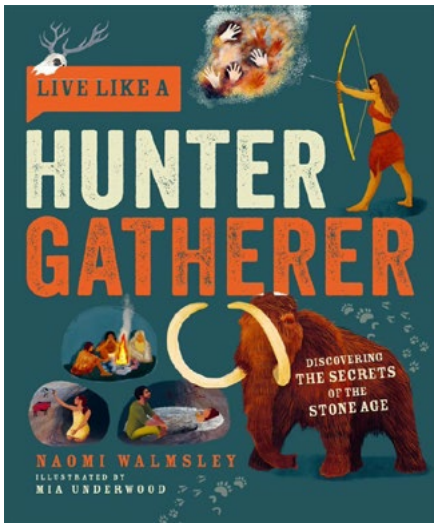


"Living in the Stone Age was a constant battle for survival. Where would your next meal come from? Was your next meal also coming to eat you too?"

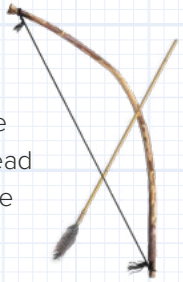
Live like a Hunter Gatherer

Be inspired by the amazing skills that early humans needed to survive in a Stone Age world.

Mathematics challenge

Finding the best bow and arrow

Did you know that scientists need to use maths when carrying out their investigations? They make measurements of their observations, and these measurements help them explain how much impact a certain change has had.



For example, if you wanted to investigate the best way to use a bow and arrow you would need to carefully measure every change that you make (perhaps the weight of the head of the arrow) and you would also need to carefully measure everything that you wanted to keep the same (such as the length of the arrow or the angle from which it was fired). You would then need to accurately measure and record the distance the arrow travelled each time. If you were changing the weight of the arrowhead you would need to take several measurements for each weight that you were comparing and then work out the average (mean) of all the measurements. This is because the arrow won't travel exactly the same distance each time and an average gives a better idea of the impact of the changes that you have made.

To carry out an investigation like this, start by following the instructions on pages 26 – 27 to make a bow and arrow. What changes will you test? How will you record the changes? How will you record your results?

Just imagine...

A world before any of our familiar technologies existed. The only way to travel would be by walking. The only way to talk to someone would be by being next to them and speaking or signalling. There would be nothing made of metal, plastic, or paper. Everything that you have would be made by you or your family; if you could not make it, you could not have it.

How would you stay safe? How would you keep warm? What would you eat?

LIVE LIKE A HUNTER GATHERER

Pupil activity sheet (continued)

Making a shelter

One of the first things that you would need to do if you were stranded away from all of the things that we use every day would be to make a shelter. Have a go at building something that would be big enough to shelter you from the sun and rain. It will need to be strong enough to withstand a strong wind. Page 14 shows how you could build a shelter if you were in woodland. However, you will need to use whatever materials you can find in your environment, just as early hunter gatherers would have done. Perhaps you can start by looking for useful materials in the PE cupboard such as hoops, cones and parachutes. Remember to test your finished shelter to make sure that it is watertight!

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Science adventurer

Thor Heyerdahl was born over 100 years ago. As a child he loved science and even created his own small museum at home. He studied science at university and became interested in how early humans were able to travel around the world. He thought that it would have been possible for stone age people to travel from South America to Polynesia. To test his ideas Thor built a boat which he called *Kon-Tiki* out of materials and technologies that would have been available thousands of years ago. He safely made the journey. This was a big breakthrough in understanding about early humans, as before that most people did not believe that it would have been possible to travel such long distances.

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Knowing the land

Early hunter gatherers knew everything about their environment. They knew what animals lived there and which plants grew there. They knew which plants and animals were useful and which were dangerous.

Let's see how well you know your environment. On your way home from school look around to see how many different plants and animals you see (don't forget tiny plants growing in the cracks of pavements and different grasses). How many do you recognise or know anything about? You can use a book or the internet to find out things, but our ancient ancestors would have to remember everything and pass it on from generation to generation. Their survival depended on it!

Shadow stick

On page 32 there are instructions for finding north, south, east and west. On a sunny day follow the instructions and then use a compass to find out if the instructions work.

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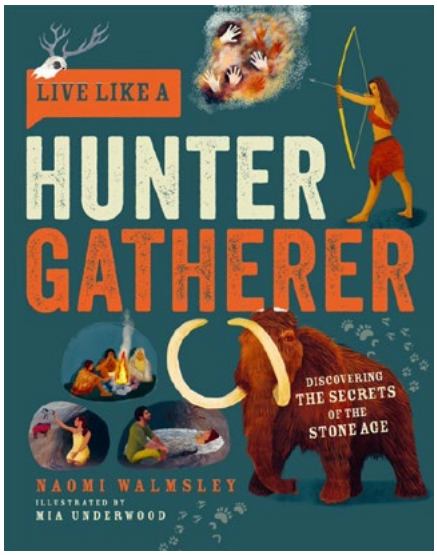

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Fire in school

Although the idea can be daunting, you do not need specialist qualifications to light fires in school. However, you do need to take sensible precautions and know what you are doing. Scan the QR code to visit the CLEAPSS website for easy-to-follow guidance. Consider joining a safety organisation if your school is not already a member.

Stone Age science

Isaac Newton encapsulated the idea of successive generations of scientists building on the work of those who had gone before when he said, 'If I have seen further, it is by standing on the shoulders of giants'. Encourage pupils to think about the science and engineering that Stone Age people did, asking questions like; What investigations did stone age people carry out? What new technologies did they invent? What would the world be like if stone age people hadn't invented the technologies that they did?

LIVE LIKE A HUNTER GATHERER

Teacher activity sheet (continued)

Waste not want not

Stone Age people understood the value of things that they had worked for, and nothing went to waste, as can be seen on pages 30 and 31 of the book. This is something that we could learn from today. Challenge pupils to consider how they could use something in their environment that would otherwise go to waste. This could include items that are usually thrown away or put out for recycling, or plants in the local environment.

Scan the QR code to access the free resource Potatoes to Plastics which shows one of the ways that modern day scientists are tackling the problems of waste in the modern world.

Fuel for the fire

Hunter gatherers' understanding of fire was vital to their survival. These hunters knew which were the best materials in their environment to use and the ideal fuels that light easily and burn for a long time without producing too much smoke.

Scan the QR code to access the free resource Renewables don't run out, which has ideas for investigations to compare the usefulness of different plant materials and oils as fuel. Once you have chosen the best oil, page 15 of the book has instructions for making a fat lamp.

Career links

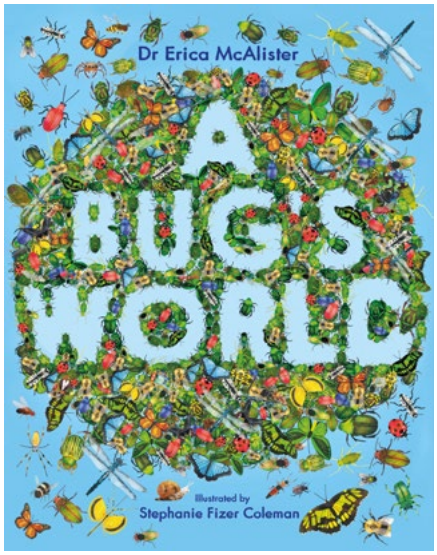
- **Experimental archaeologist**
  A lot of the activities described in this book would be carried out by an experimental archaeologist. Experimental archaeologists test theories about how prehistoric people lived by living in the same conditions. For example, experimental archaeologists have made arrow heads using the same materials that would have been available in the stone age. You could watch the four-part series 'Surviving the Stone Age' featuring this book's author, to find out more about how experimental archaeologists work.
- **Paleo geneticists**
  test ancient DNA to find out about how humans are related to other hominids such as the ones described on page 5.
- **Archaeologists**
  find out about ancient people by studying the remains that they leave behind including buildings, artefacts and human remains.

A BUG'S WORLD

Pupil activity sheet

CENTRE *for* INDUSTRY EDUCATION COLLABORATION

This is one of a series of six activity sheets to use alongside the books which have been shortlisted for the Royal Society Young People's Book Prize 2023.



"We must remember that Earth isn't just our home, it is home to other animals and insects too. We need to learn how to share it and allow these creatures to thrive."

A Bug's World

Be prepared to be amazed by the huge variety of bugs that we share our world with and learn about how insects and other creatures affect human lives.

What is what?

Do you know your butterfly from your moth? Or your millipede from your centipede? Would you recognise a shield bug or a rosemary beetle if you saw them? To carry out the activities in this activity sheet you will need to identify a wide range of small animals so make sure that you have a good quality identification guide to help you.


Lacewing


Lavender beetle


Lily beetle

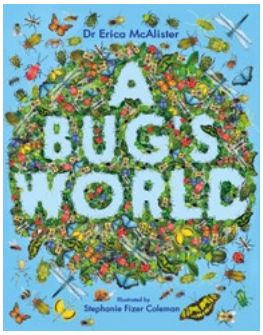
Mathematics challenge

Collecting data

How can you be sure that the new habitats that you are creating for wildlife are working? To start you need to observe how much wildlife is visiting the location before making any changes. For example, you might watch the space for a set length of time and make a note of what you see. Once your new habitat is set up (and once animals have had a chance to find it) you need to watch it again for the same length of time and at the same time of day.

If you notice any changes you will need to think of a way to show what you have noticed, perhaps with a table or graph. What would be the best way to present your evidence to convince others of the value of what you are doing and to persuade them to do something similar?

Images: Lacewing © iStock.com / xxmmxx; Lavender Beetle © iStock / marjorie anastacio; Lily Beetle © iStock / Ian_Redding.

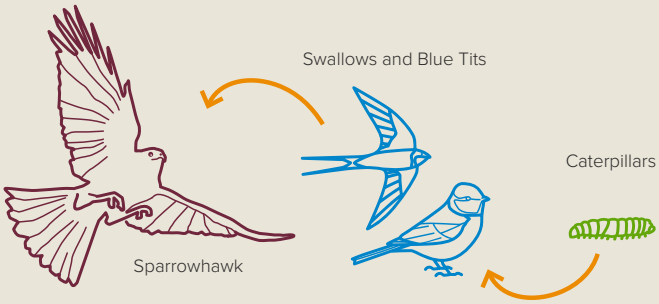


A BUG'S WORLD

Pupil activity sheet (continued)

Food chains

Did you know that lots of animals depend upon insects and other invertebrates (such as worms and spiders) for their food. If there are not enough caterpillars in the spring, blue tits and other birds cannot find enough food for their families and many of their chicks will die! The swallows and swifts flying over our heads in summer catch flying insects, such as flies and ants, to eat and feed their young. Even insects eat other insects; wasps spend most of their life collecting caterpillars and greenfly to take back to their nest and feed to their larvae.



Even animals that don't eat insects depend upon them for their survival. Sparrowhawks eat small birds such as swallows and blue tits. If these small birds starved because there were no insects to eat, the sparrowhawks would starve too. We call the way that animals are linked to each other by what they eat a 'food chain'. Can you research to find out some other food chains that have got insects in them?

Just watching

Have you ever considered what insects do all day? Find some time to sit and watch what an insect does. You might see a bee fall asleep in a flower, watch a butterfly escape from a wasp or a fly cleaning its face. The more you watch the more that you will find out. Perhaps you will even notice something that no other entomologist has ever noticed before. You could keep a record of your observations including written notes and drawings and photographs. Don't forget to include other details such as the time of year, the time of day and the weather.

Scientist profile

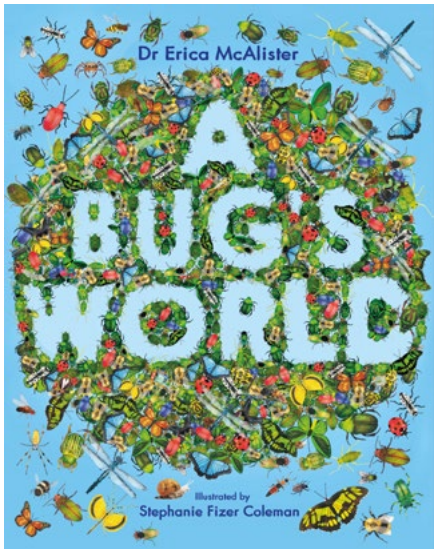


Professor David Goulson is mad about insects! One of his earliest memories is finding some yellow and black caterpillars and looking after them until he saw them transform into beautiful black and magenta moths. Now he is an adult he specialises in bees and has travelled around the world, including Borneo, Thailand, Fiordland, and Patagonia finding out about different kinds of bumble bee and what they need to survive. He also encourages a range of wildlife including grasshoppers, earwigs and ants into his own garden and loves to spend time just watching them.

A BUG'S WORLD

Teacher activity sheet

This is one of a series of six activity sheets to use alongside the books which have been shortlisted for the Royal Society Young People's Book Prize 2023.



Each activity sheet contains ideas for experiments to do with your pupils, provides information relating to careers, and has a maths focus to help pupils understand the importance of mathematics education across the curriculum.

These investigations can be done as standalone activities or carried out as an in-depth sequence to develop pupils' disciplinary and substantive knowledge. The pupils' deeper learning and their science capital development would be more memorable if they were able to collaborate with a scientist such as an entomologist or ecologist. If you work with a scientist in this way you could also consider applying for a Royal Society Partnership Grant of up to £3,000. For more information and to apply, visit: **royalsociety.org/partnership**

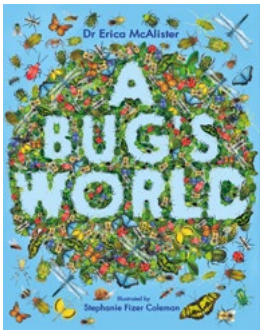
The importance of words

Mini-beasts, creepy crawlies, arthropods, invertebrates, insects ... we need to think very carefully about the words that we choose to use with pupils. In science we only use the word insect to refer to invertebrates which have six legs. If we wanted to include spiders and millipedes the correct terminology would be 'arthropod' (animals with a hard exoskeleton). To include animals such as worms and snails we would use the word 'invertebrate' which means animals without a backbone.

Children often cope well with what we think of as difficult scientific terms. However, if you do need to simplify your vocabulary make sure to avoid using the wrong words, such as 'insect' to refer to spider.

Supporting pupils

This short video from the Royal Society is useful for teachers as it highlights the significant decline in biodiversity and the consequent negative impacts. However, we must be aware of burdening pupils with too much negative information as they can feel despair and give up trying to make a difference. Instead, it is better to help young people to focus on what they can do to make a positive difference in the world.



A BUG'S WORLD

Teacher activity sheet (continued)

Creating habitats

One of the positive aspects of studying insects is how quickly some of them respond to our attempts to help them. If you make a pond, however small, it won't be long before a bee stops by to take a drink, or a water beetle moves in. If you keep a small patch of grass unmown you will not only quickly notice how many flowers appear but also how many insects turn up including flies, bees and maybe even grasshoppers. A pile of old wood, bricks or broken pots will similarly quickly be made use of by insects and other invertebrates.

Encourage pupils to think about their own school grounds and what changes they could make to encourage biodiversity. However unpromising it might seem, there will be something that they can change which will benefit wildlife. How about creating a pond in a bowl or a meadow in a plant pot? This links well with the maths activity in the pupil sheet.

Pond dipping

Every child should have the chance to go pond dipping at least once before they leave primary school; there is nothing quite like the excitement of discovering a whole new world of alien looking creatures. If you don't already have (or are unable to create) a pond in the school grounds, a local park or nature reserve may have a suitable location. Full guidance, including safety information, can be found in CLEAPSS, although many locations will have an expert on hand to lead a pond dipping expedition. Make sure that you have a good identification guide to the creatures that you might find. However, if there are some animals that you cannot identify do not be afraid to admit this to your class:
'I don't know what it is; I wonder how we can find out' is a great way to motivate pupils to investigate for themselves.

Images: © iStock.com / Lovattpics; © iStock.com / phototrip; © iStock.com / Rosendo Serrano Valera.

Career links

Entomologists study insects. Some of them specialise in a particular type of insect such as butterflies, beetles or wasps.

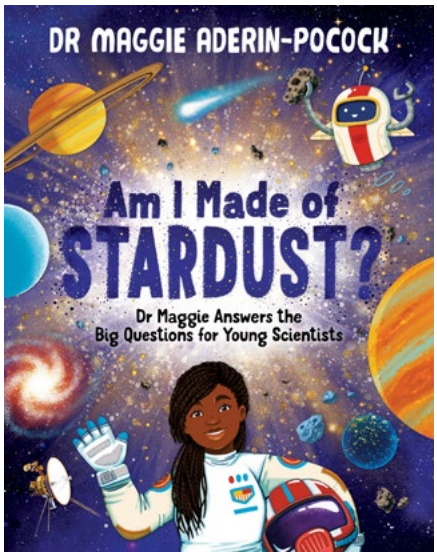
- **Arthropodologists** study arthropods including spiders, millipedes and woodlice.
- **Forensic entomologists** use their expertise about insect life cycles to find out about murder victims. For example, if it takes 3 days before the eggs of a certain fly hatch out and the maggots of that fly are found on a body the forensic entomologist can prove that a person died more than 3 days ago.
- **Museum curators** look after the exhibits in a museum. Erica McAlister, the author of this book, is senior curator at the Natural History Museum and specialises in flies.

AM I MADE OF STARDUST?

Pupil activity sheet

CENTRE *for* INDUSTRY EDUCATION COLLABORATION

This is one of a series of six activity sheets to use alongside the books which have been shortlisted for the Royal Society Young People's Book Prize 2023.



"The universe is EVERYTHING... all of space and everything in it, from galaxies and nebulae to black holes and stars. Our Earth is just a teeny, tiny part of this immense cosmic system."

Am I Made of Stardust?

Find out fascinating facts about space and think about how humans could live on other planets in *Am I made of Stardust?* by Maggie Aderin-Pocock.

Mathematics challenge

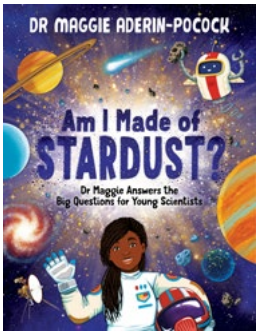
Collecting data

Have you considered how you are going to measure light levels and temperature while you carry out all your investigations into plant growth? A useful way to do this is to use a data logger which can be used to record both temperature and light levels continuously and to make graphs. Ask your teacher if there are any in school that you could use. If there aren't any available, find out about apps that can be downloaded onto tablets or phones.

Once you have experimented with the technology you will have to plan how best to use it. Although it might be interesting to see daily changes in temperature and light levels, will this be useful if you only measure growth at fixed times (for example daily or weekly)?

Yet another problem to think about is how to measure plant growth. For example, you might decide to measure height and then notice that the tallest plants don't look very healthy. Other things that you could measure are the weight of the harvest (if you have very sensitive scales) or the colour of the leaves.

These are all important discussions to have before you start your investigations. During the investigation, you should also ask yourself: 'Is this the best way to collect evidence?', 'Could there be a better way to show our findings?' It might be worth different groups measuring and recording in different ways so that you can compare your results with each other and see if you reach the same conclusions.



AM I MADE OF STARDUST?

Pupil activity sheet (continued)

Landing on Mars

Once scientists have worked out what humans will need to survive on Mars, other scientists and engineers need to work out how to get everything there safely. Because Mars has a different atmosphere to Earth, parachutes do not work as well. This means that we are going to have to work hard to develop the best parachutes possible and think of other ways to protect precious cargos landing on the surface of the planet.

Your challenge is to experiment with ways of landing a fragile cargo here on Earth. For example, you might use a raw egg (in which case a small zip lock bag will stop it getting too messy if it breaks). How are you going to SLOW the fall of your egg from a height? How are you going to cushion the fall? Why don't you get into teams and see who devises the best method to protect their precious cargo?

Scientist profile

Watch Maggie Aderin-Pocock talk about her exciting job as a space scientist, and how she became interested at a young age. She is also a science communicator helping people to understand new and exciting facts about space and often appears on TV. But did you know that she originally wanted to be an astronaut? If you find something that interests you and work hard to find out more you too will be ready to take up amazing opportunities when the time comes, even though they might not be what you originally planned. Just like Maggie.

AM I MADE OF STARDUST?

Teacher activity sheet

CENTRE *for* INDUSTRY EDUCATION COLLABORATION

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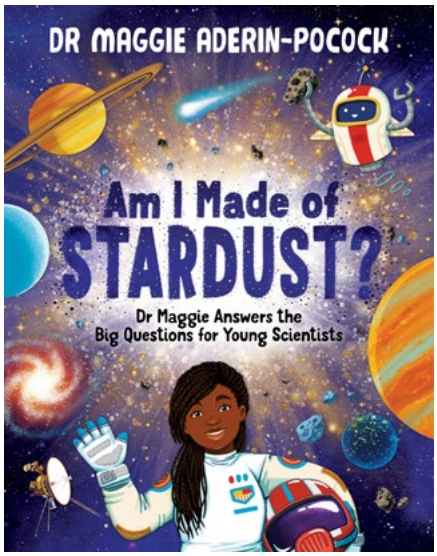


Each activity sheet contains ideas for experiments to do with your pupils, provides information relating to careers, and has a maths focus to help pupils understand the importance of mathematics education across the curriculum.

These investigations can be done as standalone activities or carried out as an in-depth sequence to develop pupils' disciplinary and substantive knowledge. The pupils' deeper learning and their science capital development would be more memorable if they were able to collaborate with a scientist such as a botanist or horticultural scientist. If you work with a scientist in this way you could also consider applying for a Royal Society Partnership Grant of up to £3,000. For more information and to apply, visit: **royalsociety.org/partnership**

Images: © iStock.com / onurdongel.

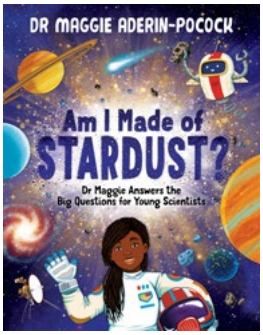
Growing food in space

The challenges of growing crops on mars

Find out what pupils already know about what plants need to grow. After using secondary research to find out what the temperature and light levels are like on Mars, invite pupils to discuss whether these are ideal conditions for growing crops for people colonising Mars. Challenge them to set up an investigation growing 'micro-greens' (salads such as mustard and lettuce which are harvested as baby leaves). Ask them to compare the impact of different temperatures and different light levels on the amount of the crop and the health of the plants.

Overcoming the challenges

Challenge pupils to think about how they could overcome some of the problems of growing food crops in the harsh conditions on Mars. Could they design a structure that would protect plants and maximise the warmth and the light? If working with a horticultural scientist, they could find out from them what humans already do to help plants grow in harsh climates or they could use secondary sources of information.



AM I MADE OF STARDUST?

Teacher activity sheet (continued)

Images: © iStock.com / Andrée_Nery.

Martian soil

Soil on earth is made of minerals and lots of 'organic matter'. Organic matter is made up of decomposed plants and animals, whereas Martian soil is comprised only of minerals and no organic matter. Challenge pupils to investigate how well plants would grow without organic matter. They could compare builders' sand with potting compost and investigate the impact of different ratios of the two different growing media. Mustard or radish grow quickly so would give quick results. However, it would be interesting to try other seeds too.

For more ideas about how pupils could explore the properties of Martian soil scan the QR code to access the free resource Is There Anyone Out There?

Irradiated plants

Away from Earth's protective magnetic field, people and plants in space are subject to much higher levels of radiation from the sun. Scientists need to investigate how this affects everything that is sent into space. For example, do seeds that have been subjected to radiation still germinate? Microwave ovens produce radiation. Put fast germinating seeds, such as radish, in a microwave on a low setting for 5 seconds. Compare with non-microwaved seeds to see if it makes a difference to germination. What do pupils notice? What happens if the seeds are microwaved for longer? What happens if the plants are microwaved after germination? A similar investigation could be planned by freezing seeds for a week to see if that affects germination.

Images: © iStock.com / VladTeodor.

Career links

Exploration of space and space travel needs collaboration between many different science and engineering disciplines. Consequently, there are a wide variety of related career opportunities.

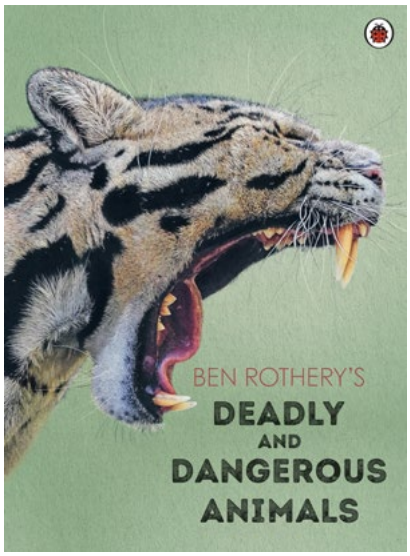
- **Astro-botanist**
  A lot of the work described in this activity sheet would be conducted by Astro-botanists.
- **Material scientists and engineers**
  Scientists investigate the properties of materials in the extreme conditions of space and engineers apply their findings to make equipment for use by astronauts as well as during unmanned missions.
- **Astronaut**
  Many scientists working in the field dreamt of being astronauts which led them into a wide range of space related careers. Page 107 has some ideas about what experiences and qualifications young people would need to be considered for astronaut training.

BEN ROTHERY'S DEADLY AND DANGEROUS ANIMALS

Pupil activity sheet

CENTRE *for* INDUSTRY EDUCATION COLLABORATION

This is one of a series of six activity sheets to use alongside the books which have been shortlisted for the Royal Society Young People's Book Prize 2023.



A beautiful collection of deadly and dangerous animal profiles carefully researched and stunningly illustrated by animal-loving, detail-obsessed artist Ben Rothery who grew up wanting to be a shark, a dinosaur, or David Attenborough crossed with Indiana Jones! Ben brings those relatable fantasies to life on paper with his unnecessarily large collection of very sharp pencils.

"When we think of deadly and dangerous animals, we often imagine the biggest hunters with the longest claws and the sharpest teeth. But there's much more to it than that."

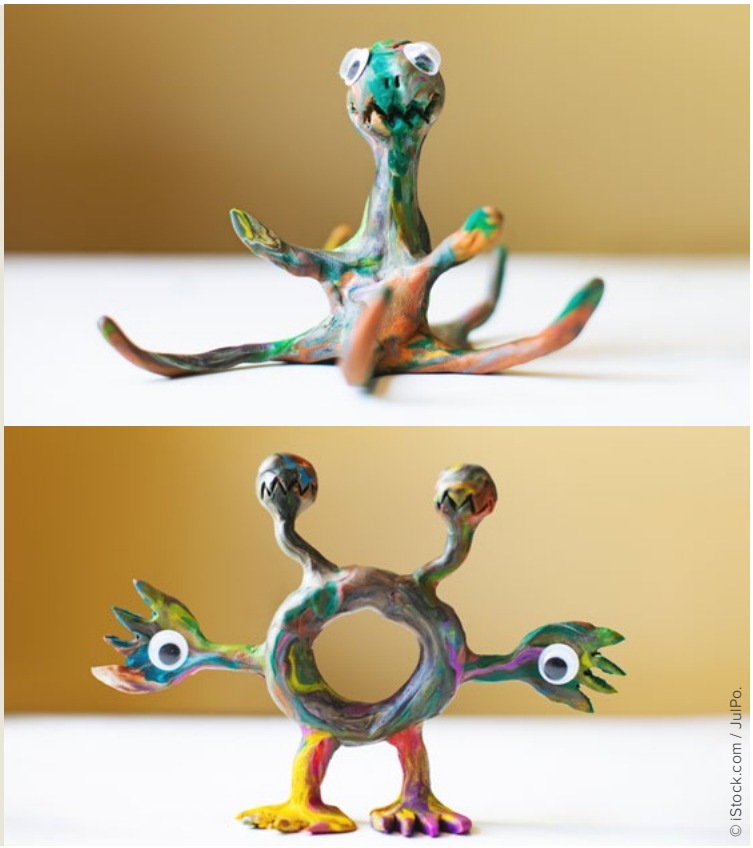
Deadly and Dangerous Animals

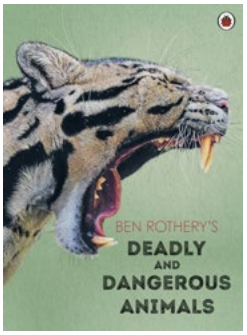
Create a critter

Thinking about your observation station, design an animal that would be adapted perfectly to live in that environment. Would it be tall or short? Would it benefit from excellent eyesight to hunt its prey? Does it hunt at night or during the day? What does it eat? Does it need to be able to climb, fly, swim, or something else?

Now you have your predator characteristics decided, what would it need to do to protect itself from being the prey of another animal? Can it move quickly? Can it see in the dark? Does it mimic another more dangerous animal or have markings to confuse its hunter?

You might decide to draw your animal on paper or digitally. You could use photo editing tools to bring a collage image together using other animal parts. Perhaps consider making your creature out of plasticine, Lego, or junk modelling items.





BEN ROTHERY'S DEADLY AND DANGEROUS ANIMALS

Pupil activity sheet (continued)

Comparing creatures

Make a list of 10 – 12 animals from those you have observed in your activities so far which capture your interest. Make sure there is a good variety of animal types such as mammals, invertebrates, birds, and amphibians.

Gather animal facts including their average height, length, weight, speed, and the type of diet they have (herbivore, carnivore, omnivore) and turn your findings into fact cards including an image of the animal and their key facts, a bit like a top trumps card.

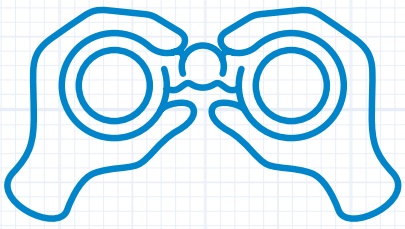
Compare the animals based on the facts. Can you see any patterns? Do smaller animals have anything in common? Do carnivores share any features? Are taller animals always longer? Do animals with more legs move quicker?

If you want to research a little further, you could also include gestation periods (how long it takes babies to grow) and their heart rates based on beats per minute (bpm).

Mathematics challenge

Pick a wildlife watching area. You can use your observation station or select a different type of habitat. This can be as big or as small as you like. Watch for half an hour to see which animals are visiting regularly and make a list. You could use animal identification books, search online, or download apps to help you name each animal.

What investigation questions are you already working on? Can you collect more data to make your results even better? You may decide to answer another question if your new observation area is very different to your first one. Try to spend some time observing your wildlife area each day. You may also wish to record temperature, rainfall, and other weather conditions each time you observe to see if they have any effect.



How will you present your findings? This could be a results table, photo diary, poster, presentation, or anything else you think might work well.

Scientist profile

Meet Dr Tanesha Allen, a zoologist and behavioural ecologist who studied at the University of Oxford. Zoology is the study of the behaviour of animals in their natural environment making observations and gathering information like what they eat, where they find shelter, and diseases they might have.

Tanesha has done a lot of research about badgers in the wild, asking questions about their behaviour and designing experiments to answer her questions. She says loving animals, getting messy, and being creative are all essential skills for a zoologist.

As well as her own studies, Tanesha is a passionate science communicator and has been involved in community outreach work, taking part in a Royal Society Partnership Grant, teaching school pupils how to monitor the wildlife on their school grounds.

DEADLY AND DANGEROUS ANIMALS

Teacher activity sheet

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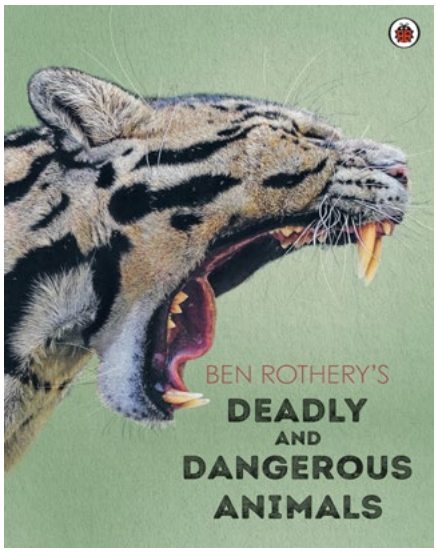

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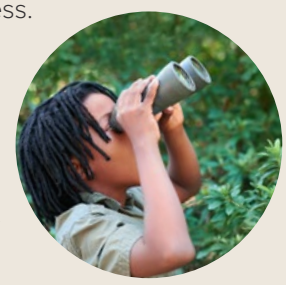
Observation station

Identify an area in your school grounds or local park that you will use for wildlife observation depending on the type of animals you would like to study. This might be a bug hotel, a bird box, a butterfly feeding station, a bird feeder, a solitary bee house, a bird bath, a hedgehog highway, a wildflower patch, a plant pot pond, a bat box... the list is endless.



Set up a long-term wildlife monitoring project. Ask the pupils what they would like to find out and to design investigations which would allow them to answer their questions. You might consider the following:

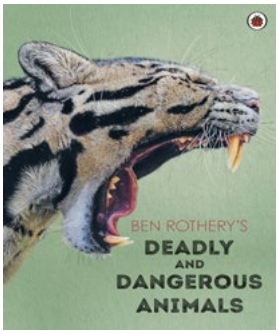
- How many different animals visit?
- What time of day is a specific animal likely to visit?
- Do different animals visit at different times of the day / year?
- What attack or defence strategies do the animals use?
- What food chains can be seen in action?
- Which class of animals visit most often? Eg mammals, invertebrates, birds

A camera trap can be a great addition to allow round the clock observations.

You might choose to visit different habitats over the course of your project in order to compare results, such as ponds, rivers, seaside, woodland etc.

Scan the QR code to watch this two-minute video segment from the Royal Society's Summer Exhibition (starting at 54:36), to find out how older school pupils carried out a similar project in their school grounds.

Images: (left) © iStock.com / PeopleImages; (above) © iStock.com / stefbennett.



DEADLY AND DANGEROUS ANIMALS

Teacher activity sheet (continued)

Are all animals deadly and dangerous?

This incredible collection of deadly and dangerous animals has the potential to leave pupils feeling like there are animals to be feared hiding around every corner. The reality is, most animals we encounter day-to-day do not pose a threat to us, but all animals are deadly to something, even if that something is some seriously nibbled leaves resulting from a seasonal boom in the caterpillar population.

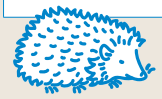
Predator / prey

During your wildlife observation project, the pupils will see various predators and prey in action. Take time to carry out some secondary research into the different animals which visit your observation station to find out more about them. The more pupils know about the wildlife around them in their local environment, the more likely they are to act as responsible conservationists in their daily lives.

A few defence strategies were highlighted earlier but let's take some time to dig a little deeper to get a fuller picture of the range of defence and attack strategies which might be used by the animals in your observation station, the book, and beyond.

Here are some you might consider:

Predator attack strategies
ambush, pursuit, stalking, venom, claws, web trapping, senses (eg echo-location) extending limbs/tongue
Prey defence strategies
Foul smells, confusing sounds, warning colours, playing dead, mimicry, large numbers of young, camouflage



Caterpillar camouflage

To defend themselves against predators, prey animals deploy a fascinating array of survival strategies like burrowing underground, emitting foul smells, and camouflage.

Explore the evolutionary benefit of disguise with this fun Caterpillar Camouflage game to kickstart a sequence of activities that will enable pupils to become more aware of the incredible wildlife in their natural surroundings.

Career links

- **Naturalists** study the natural world and the patterns of each species within their environments and in captivity. They work to understand how different species interact with each other, and the world around them. David Attenborough and Michaela Strachan are naturalists you may have heard of or seen on TV.
- **Ecologists** observe the relationship between plants and animals, and between living things and their environments. They work to discover how different species depend on each other and their surroundings.
- **Conservationists** dedicate their time to actively protecting biodiversity (the variety of life on Earth), single species, or habitats. This could be in your local area or anywhere in the world. Not all conservationists are trained scientists; anyone can get involved.

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