# OUR COLOURFUL WORLD

When you picked up this book, you may have been attracted to its bright colours or the rainbows on the cover. Can you name all the colours you can see? Which colours are most easily visible to humans? How does the natural world use colour to help it survive?

You'll discover the answers to these questions – and many more – as you make your way through this book. We'll talk about light (the most important thing) and waves (not the kind you see at the beach – though you will learn why the sea looks blue!). You'll find out how some animals are able to glow in the dark and how others change their colours to hide from predators. You'll also discover why leaves change colour in the autumn, why your veins look blue but your blood is red, and how the language we use shapes the colours we see.

And you'll learn exactly how to make a rainbow – in space.

So, first things first . . .

# WHAT IS COLOUR?

Emit: produce, or make.

## COLOUR IS HOW WE SEE LIGHT

Light can come to us in two ways – direct or reflected. Direct light comes from something light-emitting, like a lamp or the Sun. Reflected light bounces direct light off the surface of something, like a table or a desk. Either way, our eyes pick up the light and enable us to see different colours.

## VISIBLE LIGHT

The colours we can see come from visible light. This is any light that we humans are able to see with our eyes.

Humans can see three primary colours (red, green and blue) and the rest of the colour spectrum comes from mixtures of those three colours. You might be surprised to see green called a primary colour, and not yellow – this is because green is a primary colour for light. If you mix green and red when you're painting, you'll get a brown colour – but when green and red light are mixed, they make the colour yellow!

Visible light is part of a spectrum called the electromagnetic spectrum. Did you know that light is actually a type of energy? This energy is called electromagnetic radiation.

Apart from visible light, we can't see the majority of the electromagnetic spectrum with our eyes. Although we can't see them, machines that use the other energies that sit on the spectrum – like X-rays and microwaves – are part of our everyday lives. Can you think of any others?

**THE ELECTROMAGNETIC SPECTRUM CONTAINS MANY DIFFERENT TYPES OF LIGHT, INCLUDING:**

- Gamma rays
- X-rays
- Ultraviolet light
- Visible light
- Infrared light
- Microwaves
- Radio waves

**NO PINK?**

The colour we see as 'pink' doesn't have a distinct wavelength in the way that the colours of the rainbow do. We see pink when our eyes register a mixture of red and blue light – which are at opposite ends of the visible spectrum.

## LIGHT vs VISIBLE LIGHT

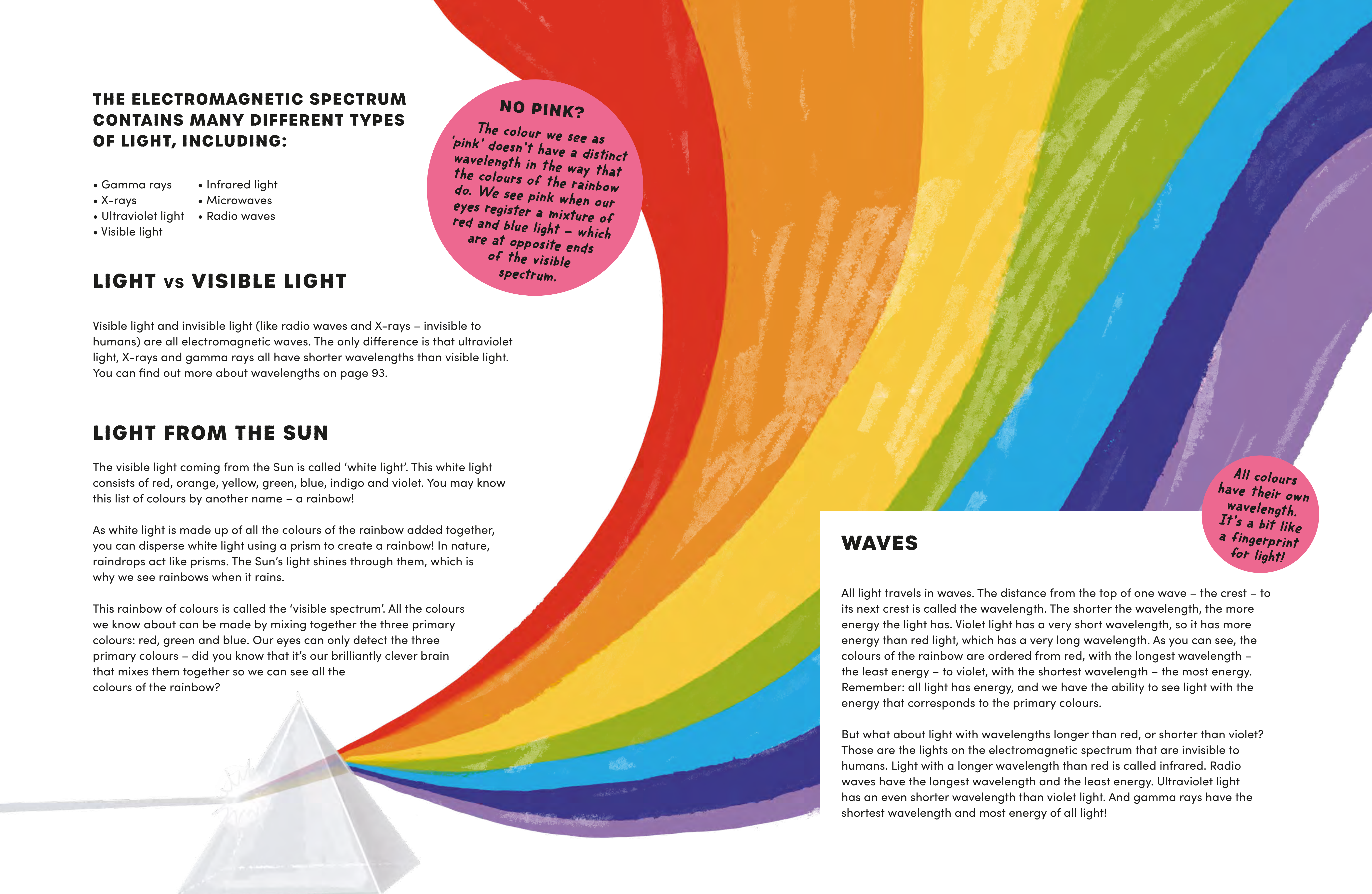
Visible light and invisible light (like radio waves and X-rays – invisible to humans) are all electromagnetic waves. The only difference is that ultraviolet light, X-rays and gamma rays all have shorter wavelengths than visible light. You can find out more about wavelengths on page 93.

## LIGHT FROM THE SUN

The visible light coming from the Sun is called 'white light'. This white light consists of red, orange, yellow, green, blue, indigo and violet. You may know this list of colours by another name – a rainbow!

As white light is made up of all the colours of the rainbow added together, you can disperse white light using a prism to create a rainbow! In nature, raindrops act like prisms. The Sun's light shines through them, which is why we see rainbows when it rains.

This rainbow of colours is called the 'visible spectrum'. All the colours we know about can be made by mixing together the three primary colours: red, green and blue. Our eyes can only detect the three primary colours – did you know that it's our brilliantly clever brain that mixes them together so we can see all the colours of the rainbow?



All colours have their own wavelength. It's a bit like a fingerprint for light!

## WAVES

All light travels in waves. The distance from the top of one wave – the crest – to its next crest is called the wavelength. The shorter the wavelength, the more energy the light has. Violet light has a very short wavelength, so it has more energy than red light, which has a very long wavelength. As you can see, the colours of the rainbow are ordered from red, with the longest wavelength – the least energy – to violet, with the shortest wavelength – the most energy. Remember: all light has energy, and we have the ability to see light with the energy that corresponds to the primary colours.

But what about light with wavelengths longer than red, or shorter than violet? Those are the lights on the electromagnetic spectrum that are invisible to humans. Light with a longer wavelength than red is called infrared. Radio waves have the longest wavelength and the least energy. Ultraviolet light has an even shorter wavelength than violet light. And gamma rays have the shortest wavelength and most energy of all light!

# HOW DO WE SEE COLOUR?

## OBJECTS REFLECT LIGHT

Have a look around! What can you see? A few things you spot might make their own direct light – a mobile phone, a table lamp, the TV. These are known as luminous objects. However, most objects do not make their own light. These objects are non-luminous, and instead reflect the light given off by the luminous objects.

## A IS FOR APPLE

From where I'm sitting, I can see a red apple. Light from the Sun outside is shining through my window, on to the apple. The apple is a non-luminous object, and so it absorbs some of the light – but some light bounces off it and into my eyes.

This reflected light enters the eye through the pupil (the opening in the middle). The light hits the back of the eye, the retina. On the retina, there are tiny cells that react to light. These are called rods and cones.

The job of the rods is to detect lightness and darkness, so they are most sensitive to black and white. The job of the cones is to detect bright light, or colours. The cones behave differently if they sense red, green or blue light – the primary colours.

When the light from the red apple activates the cones, it sends an electrical signal to the brain along the nerves. When the brain gets the signal from the cones, it sends it back with a colour – in this case, red!

If you add all colours of light together equally, you make white light for a white object. If you add none of the colours of light, the result is the absence of light: a black object.

## PAINTING WITH LIGHT

Apart from white and black, the way light mixes to make different colours is very different from the way coloured paint is mixed, as we know from the difference between primary colours in your paintbox and primary colours for light. For example, when it comes to light, if you mix red and green, you get yellow. You can do some really clever colour mixing with light if you know which colours to add or subtract.

## COLOUR BLINDNESS

Sometimes, parts of the eye may not work as we expect them to. This means some people don't see certain colours, or any colours at all. This is called colour blindness. People with colour blindness might not be able to tell the difference between certain colours. Some people are born with colour blindness, or it can happen because parts of the eye, nerves or brain become damaged during someone's life.

Some animals, like dogs and some species of monkeys, have evolved to be colour blind, so that they can detect things in dark or in low-light conditions more easily.

*Evolution is the gradual changing and developing of a species over time.*

As we now know, humans can only see the visible light spectrum. We can't see other parts of the electromagnetic spectrum, like ultraviolet or infrared, unless we use special cameras or telescopes.

But did you know that some animals can see much more than the visible spectrum? Reindeer, birds, bees and fish can see in ultraviolet, and snakes, frogs and insects can see infrared! The natural world is full of astonishing facts, and you're about to discover a lot more of them.

So now we know how we see light, and therefore colour. But what use does colour have in the world we live in? Get ready to embark on a truly eye-opening journey through the universe, with a rainbow of visible light as our guide.

**SUPER-VISION:**
People with colour blindness might be able to detect camouflage more effectively because of the way their colour receptors work. While they might not be able to differentiate well between red, orange and green, they could have extra sensitivity to other shades, like khaki.