Royal Botanic Gardens Kew

Explore Naturally Brilliant Colour in the Shirley Sherwood Gallery

A trail for families and schools

1 May – 26 September 2021

Art trail

This booklet will help you to understand some of the themes in the Naturally Brilliant Colour exhibition that link art with science.

The booklet is designed to be used by families and school groups. It highlights a number of artworks to look at more closely and poses questions for you to think about.

There are also some 'wow facts' as well as a few activities to do in the Gardens and glasshouses.

Introduction

You will see throughout this exhibition that colour is vitally important for all living things.

Different people often see colours differently.

Is the dress cream and gold or blue and black?

Do you remember this photograph that appeared on the internet a few years ago?

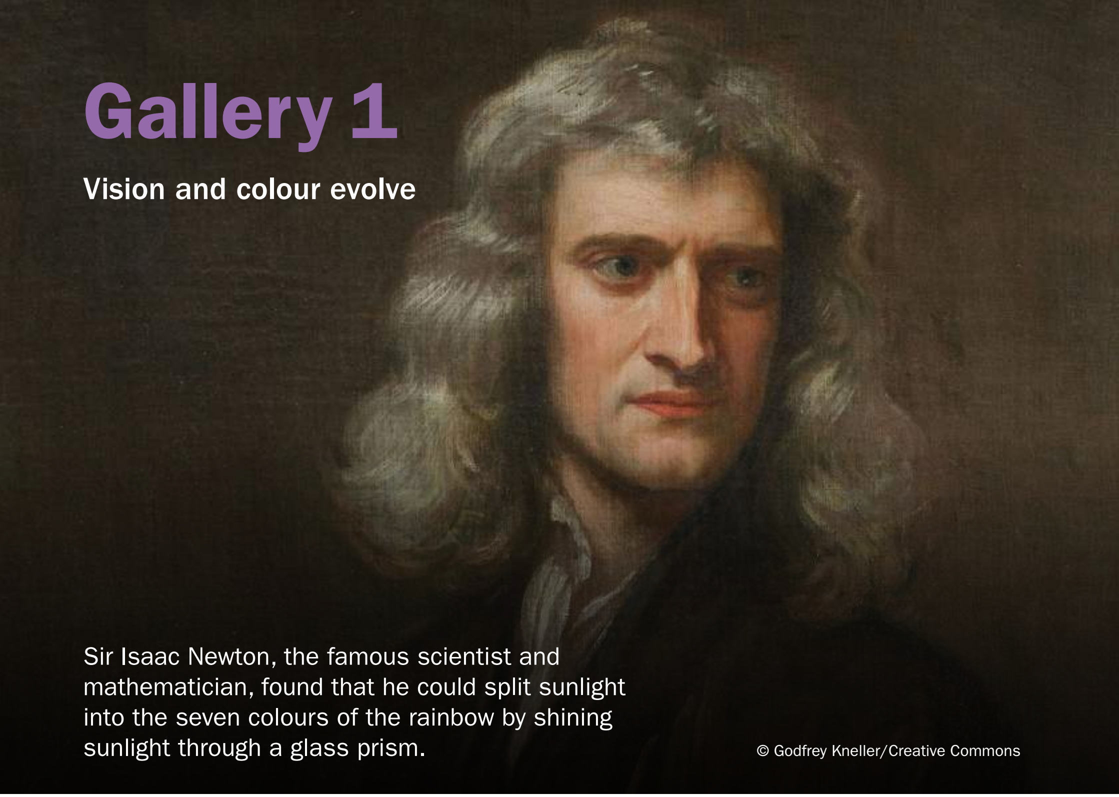
Some people saw the colours of the dress as cream and gold, while others thought it was blue and black.

This shows that humans sometimes see colours differently.

In this exhibition you will see how animals' experiences of vision and colour have evolved over millions of years, before humans even existed!

Gallery 1

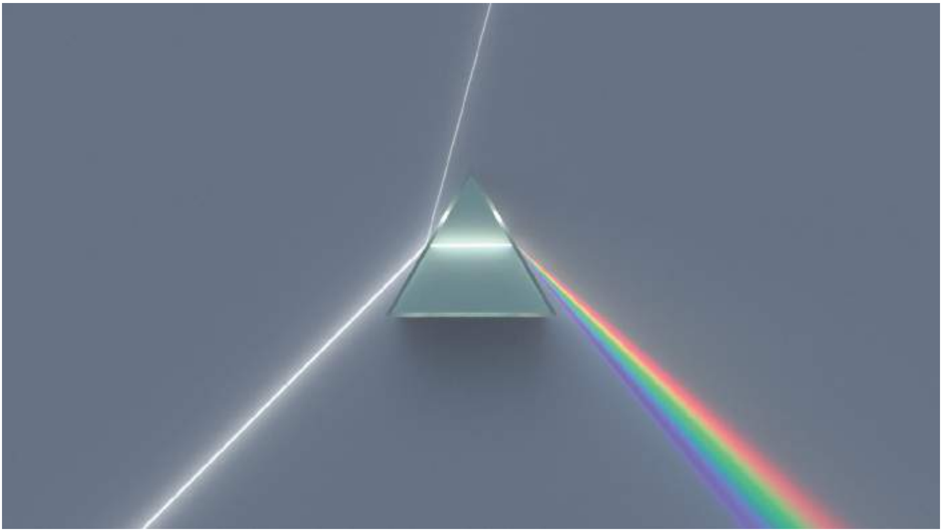
Vision and colour evolve



Sir Isaac Newton, the famous scientist and mathematician, found that he could split sunlight into the seven colours of the rainbow by shining sunlight through a glass prism.

White light

White light is ordinary daylight from the sun. It appears colourless, but is actually made up of the seven colours of the rainbow.



Light from the sun travels in waves like the waves in the sea. Rainbows are formed when light travels through water droplets in the air and splits into different colours. This is why rainbows sometimes appear when the sun comes out after a rain shower.

Sunlight also produces **ultraviolet light waves** which are invisible to humans but can be seen by insects and some birds. Ultraviolet light waves can damage our skin, which is why we protect ourselves by wearing sun cream.

Can you name the colours of the rainbow in their correct order?

How many different colours can you see in this painting?

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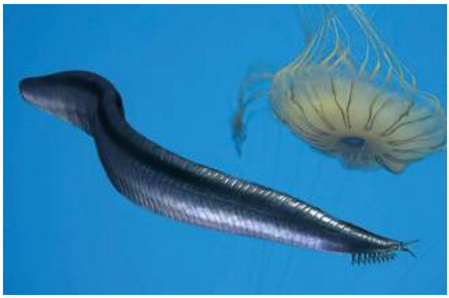
© Andrew Parker/Lifescaped

In the centre of this artwork (below left) is a painting of an extinct *Pikaia*, a marine animal that lived over 500 million years ago.

© Andrew Parker/Lifescaped



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Wow fact

Millions of years ago, before plants existed on land, life on earth changed. This was known as the **Big Bang** of animal evolution. Scientists call this the '**Cambrian explosion**'.

At this time animals evolved eyes and were able to recognise colours. They also evolved the ability to move quickly to find food, and were able to protect themselves against predators.

Colour is important

Plants and animals use colour to survive. They can use it as camouflage to hide from other animals or as a means of attracting animals to them for reproduction.

Colour is often used as a warning to scare away animals that are threatening. For example, some types of fungi have red markings to show that they are poisonous.

Amanita muscaria

Things to do in the Gardens

- Visit the dry desert zone in the Princess of Wales Conservatory, to see how the amazing *Lithops* plants use colour as part of their camouflage. Find out why these plants are known as ‘living stones’.

Lithops

Colour types

In this exhibition you will see artworks showing the four different types of colour.

Type 1: pigment colour

© Evan-Amos/Creative Commons

Pigment colour, the most common type of colour in nature, is found in most paints and dyes. Pigment colours were traditionally made from powdered materials found in the earth, such as clay and rock, or from other natural materials. Methods of producing coloured pigments artificially, using chemicals, have been in existence for many hundreds of years.

We see pigment colours when certain light waves are reflected from the object and all other light waves are absorbed by the object. When we look at a banana, for example, we are seeing the yellow light waves reflected from the banana and all the other light waves absorbed by the banana.

Type 2: fluorescent colour

We see **fluorescent colour** when certain light waves, called ultraviolet waves, that **can't** be seen by humans, are absorbed by the object and changed into light waves that **can** be seen by humans. Fluorescent colours are often very bold and bright because compared with pigment colour, many more light waves are absorbed and then reflected by the object. Looking at so many light waves at the same time means fluorescent colours appear more intense than pigment colours.

Fluorescent colours are often added to pigment colours, making the overall appearance brighter than if using pigments alone.

Type 3: bioluminescent colour

Bioluminescent colour is produced in living things, through a series of chemical reactions, without using sunlight. It's a little bit like a glow-stick you might see at a birthday or other celebration. Some plants and animals make their own chemicals to produce bioluminescent colour, while others may have bacteria living in them that produce the bioluminescent light. This type of colour is often seen in the dark or under the sea.

© Alexey Sergeev/Mushroom Observer

Type 4: structural colour

Structural colour is seen when some wavelengths (or colours) in white light are reflected off very tiny structures. A hummingbird has these tiny light-reflecting structures, so small they can only be seen with a microscope, buried under the surface of its feathers. Its colour and brightness changes when you look at it from different angles. This is referred to as iridescence. Structural colour is the brightest form of colour in nature.

Gallery 2

From light rays to colour

- Look at these dot paintings from a distance.
- How do the colours in each painting look different?
- Without looking at the labels, can you guess which type of colour was used to make the dots?
- Which painting do you think has the brightest colour?

Wow fact

Some flowers use ultraviolet or fluorescent colour markings to guide insects to their nectar. Humans can't always see these markings, because ultraviolet light is invisible to us and the fluorescent colour is not bright enough for us to see in ordinary daylight. These markings are called nectar guides and although humans can't see them, they are visible to insects and some birds.

A hoverfly (*Eupeodes corollae*) finding the nectar in a flower by following the nectar guide markings.

Things to do in the Gardens

- As you walk around the Gardens and the glasshouses, take a closer look at the flowers, making sure not to damage them.
- Try to find flowers in the Gardens that have nectar guides. Here are some to look out for.

Penstemon digitalis

© Egon Krogsgaard

Calendula officinalis

© Igor Sheremetyev

Digitalis purpurea

Have you ever tried to paint a picture but had trouble getting the colour just right?

These hummingbird artworks show how hard it is to reproduce the exact colours of nature using pigment colours on paper.

Lesbia nuna (the green-tailed trainbearer)

Cynanthus smaragdicaudus (the green-tailed sylph)

- Compare these two artworks by John Gould.
- The artwork on the left is unfinished and has not been painted. You can see how the gold leaf was added before the paint.
- Look carefully at the second artwork. Can you see the gold leaf underneath the paint? Do you think it makes the colours look bright?

Heliconia bihai with female hummingbirds *Eulampis jugularis*

Heliconia caribaea with male hummingbirds *Eulampis jugularis*

- Take a look in the display cases.
- How is the colour of the taxidermy hummingbirds in the cabinets different from the colour of the hummingbirds in the artwork on the wall?
- Why do you think this is?

Things to do in the Gardens

Although we don't have hummingbirds in the United Kingdom, we do have plants from all over the world – and some of them are loved by hummingbirds.


Salvia fruticosa


Fuchsia fulgens

- Look around the Gardens and the glasshouses to see if you can find them.
- Use the plant labels nearby to help you identify them.
- You may be able to spot some of them on The Broad Walk, in the Agius Evolution Garden or by the wall along the side of the Rock Garden.

Pollia

Micro-technology, here in the form of using extremely small pieces of colour, has been used to produce this painting. The colour is made from Pure Structural Colour flakes that copy the structural colour of the real *Pollia* fruit.

- Use the mirror on the wall to look at the *Pollia* fruit.
- Does the colour look different when you look at it in the mirror?
- Why do you think this is happening?

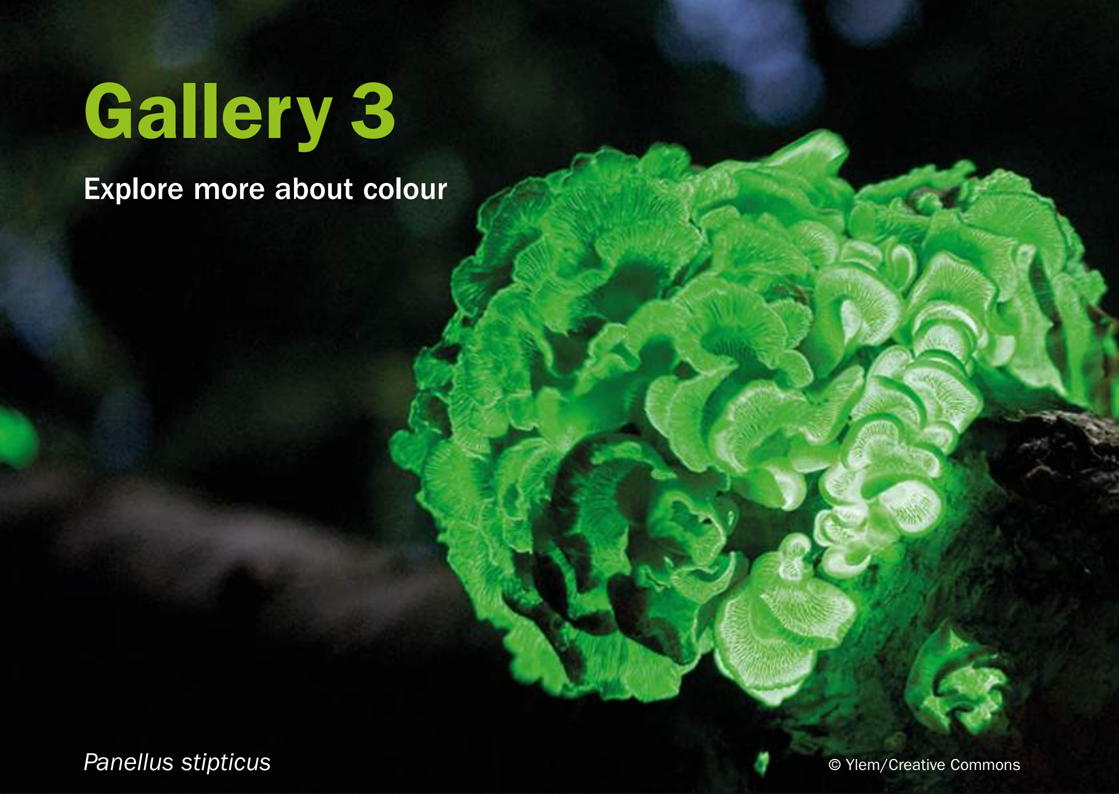
Wow fact

This is the first painting ever to use Pure Structural Colour.

Kniphofia uvaria 'Nobilis'

Gallery 3

Explore more about colour



Panellus stipticus

Omphalotus subilledens

Pigment colour has been used in this watercolour painting of fungi.

The Colours of Brittlegills

Wow fact

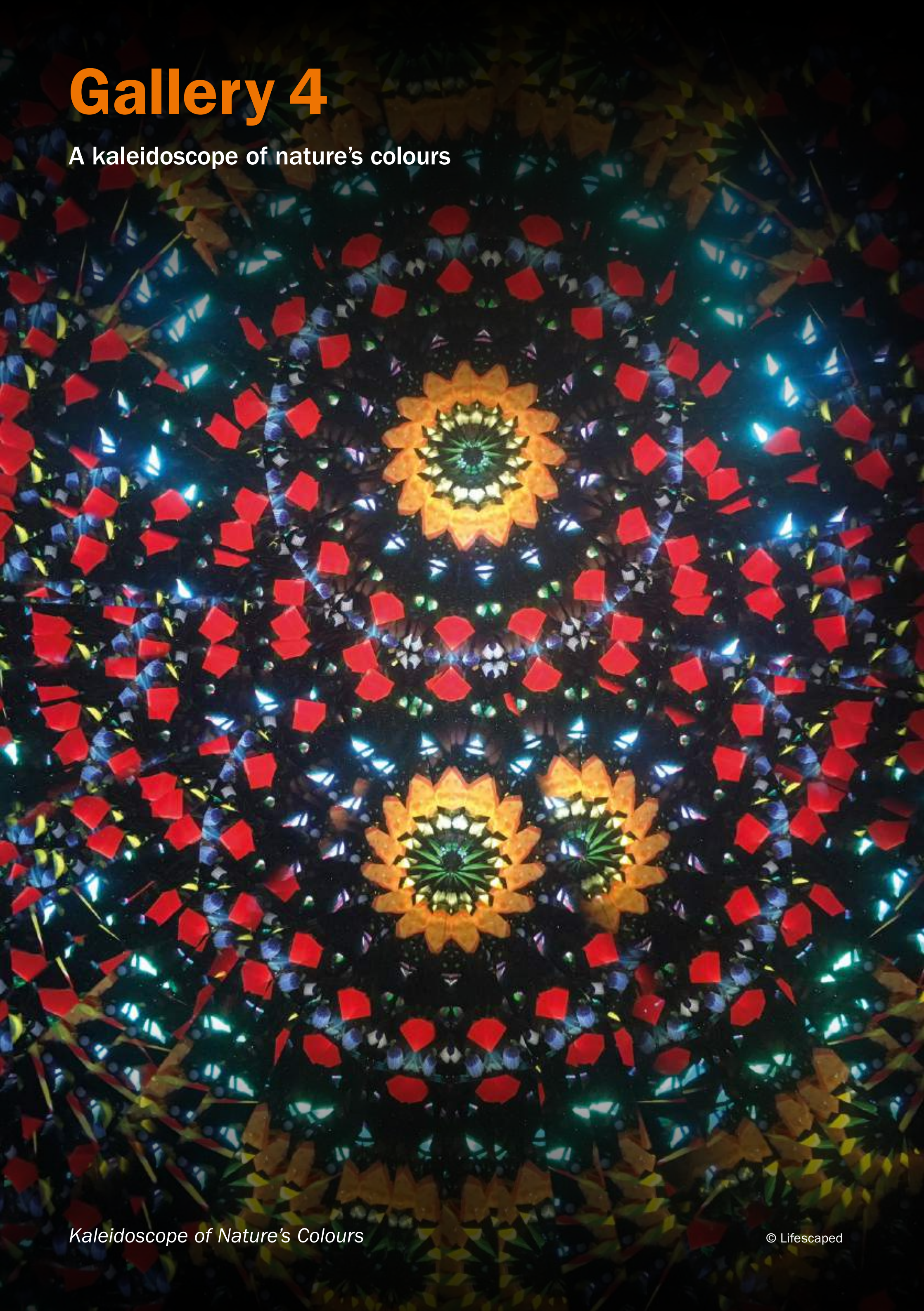
There are at least 75 species of fungi that produce bioluminescent colour. They all produce the same green glowing colour.

Scientists are researching ways that bioluminescent colour can be used to help the survival of the planet, by producing light that can be made without damaging the environment. They are developing ways to alter plants so they can naturally make the chemicals needed to produce bioluminescent colour.

In the future, bioluminescent trees could be used to light up roads instead of street lamps.

Gallery 4

A kaleidoscope of nature’s colours



Kaleidoscope of Nature’s Colours

© Lifescaped

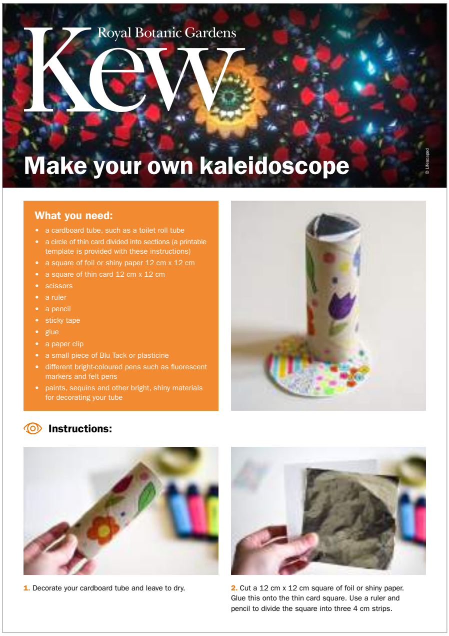
This kaleidoscope was made using lenses and glass pieces. Each piece of glass is coloured with structural colour or pigment colour. A ring of white lights is used to light up each of the coloured pieces equally.

A camera captures images through the eyepiece as the kaleidoscope turns – producing live images that are projected onto the screen.

- Can you identify any differences between the colours in the kaleidoscope?
- Can you spot which are the structural colours and which are the pigment colours?

Something to do at home

Try making your own kaleidoscope using recycled materials.
You will find the instructions for making a homemade kaleidoscope available to download from **kew.org.**



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Make your own kaleidoscope

© Lifescaped

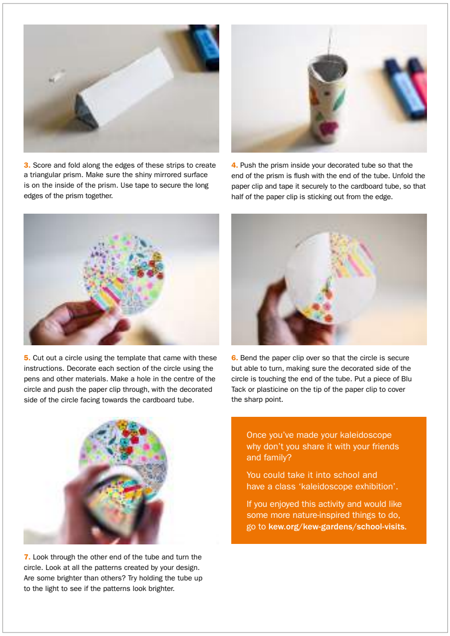
What you need:

- a cardboard tube, such as a toilet roll tube
- a circle of thin card divided into sections (a printable template is provided with these instructions)
- a square of foil or shiny paper 12 cm x 12 cm
- a square of thin card 12 cm x 12 cm
- scissors
- a ruler
- a pencil
- sticky tape
- glue
- a paper clip
- a small piece of Blu Tack or plasticine
- different bright-coloured pens such as fluorescent markers and felt pens
- paints, sequins and other bright, shiny materials for decorating your tube

Instructions:

1. Decorate your cardboard tube and leave to dry.

2. Cut a 12 cm x 12 cm square of foil or shiny paper. Glue this onto the thin card square. Use a ruler and pencil to divide the square into three 4 cm strips.



3. Score and fold along the edges of these strips to create a triangular prism. Make sure the shiny mirrored surface is on the inside of the prism. Use tape to secure the long edges of the prism together.

4. Push the prism inside your decorated tube so that the end of the prism is flush with the end of the tube. Unfold the paper clip and tape it securely to the cardboard tube, so that half of the paper clip is sticking out from the edge.

5. Cut out a circle using the template that came with these instructions. Decorate each section of the circle using the pens and other materials. Make a hole in the centre of the circle and push the paper clip through, with the decorated side of the circle facing towards the cardboard tube.

6. Bend the paper clip over so that the circle is secure but able to turn, making sure the decorated side of the circle is touching the end of the tube. Put a piece of Blu Tack or plasticine on the tip of the paper clip to cover the sharp point.

7. Look through the other end of the tube and turn the circle. Look at all the patterns created by your design. Are some brighter than others? Try holding the tube up to the light to see if the patterns look brighter.

Once you've made your kaleidoscope why don't you share it with your friends and family?

You could take it into school and have a class 'kaleidoscope exhibition'.

If you enjoyed this activity and would like some more nature-inspired things to do, go to **kew.org/kew-gardens/school-visits.**

Gallery 5

Pure Structural Colour in art

Emerging Fern

- Which of the four types of colour do you think have been used in these artworks?
- What colours can you see when you look at them from the front?
- Does the colour look different when you look at it in the mirror?

Stimulus

Bio-inspiration

Bio-inspiration is when something originally evolved in nature inspires humans to develop something new for our own purposes.

Many commonly used items have been inspired by nature. Velcro was invented when an engineer, George de Mestral, noticed that his dog was covered in seeds after a walk in the woods. Inspired by the way the seeds attached to his dog's fur, he went on to design a product that we use every day – your first pair of shoes might have used Velcro!

Pure Structural Colour is an example of bio-inspiration. It can be used as an alternative to the traditional pigments found in paints and dyes, and in some cases it has the advantage of being better for our environment.

Nature can help us to develop products that are biodegradable and less harmful to the environment. Can you think of anything like this that you use?

Finally…

This exhibition highlighted four types of colour found in nature.

- Can you remember all four?

They are:


Pigment colour
© imalabstudio/Pixabay


Fluorescent colour
© Alexey Sergeev/Mushroom Observer


Bioluminescent colour
© Eirik Solheim/Creative Commons

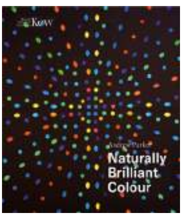

Structural colour
© Stux/Pixabay

The exhibition has shown us how humans are inspired by nature to develop resources that we can use.

The development of Pure Structural Colour is an example of art and science coming together to develop brand new bright colours that mimic the colours found in the natural world.

As you walk around the Gardens, think about how nature could inspire you.

Keep your eyes open for interesting shapes, colours, patterns, textures or any other parts of a plant that could be the inspiration for a new product design for the future.



Naturally Brilliant Colour

Order your copy of the book from **kew.org/shop** and read more about the amazing colours of the natural world.

Printed on uncoated, 100% recycled paper.