

# PARAM SCIENCE MAGAZINE

"Colour! What a deep and  
mysterious language, the  
language of dreams."  
-Paul Gauguin.

## Birthdays

1

4

15

30

A  
P  
R  
I  
L

1776

1938

1452

1777

Sophie  
Germain

Ananda Mohan  
Chakrabarty

Leonardo  
Da Vinci

Carl  
Freidrich Gauss

APR  
2023

UPCOMING  
SCIENCE DAYS

world health day

0 7

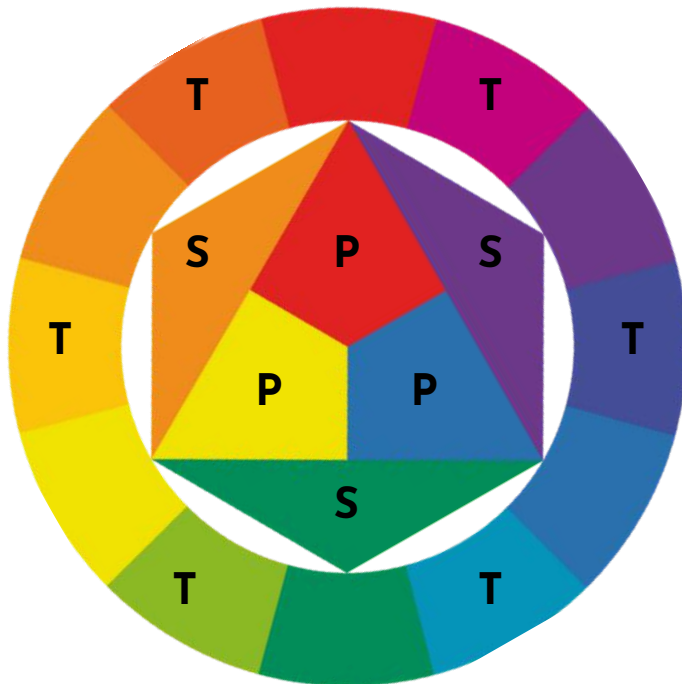
world liver day

1 9

earth day

2 2

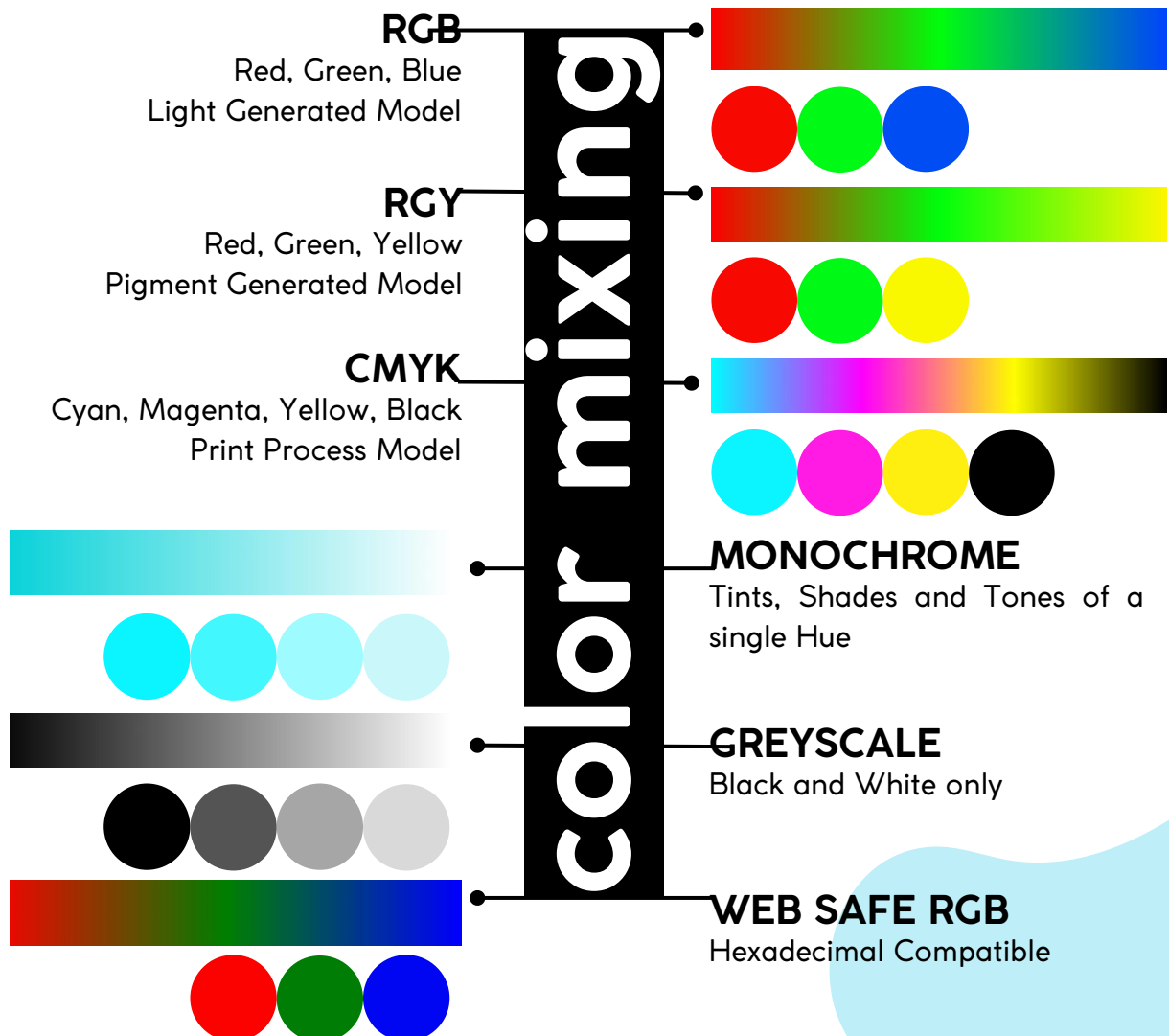
# SCIENCE OF COLOUR



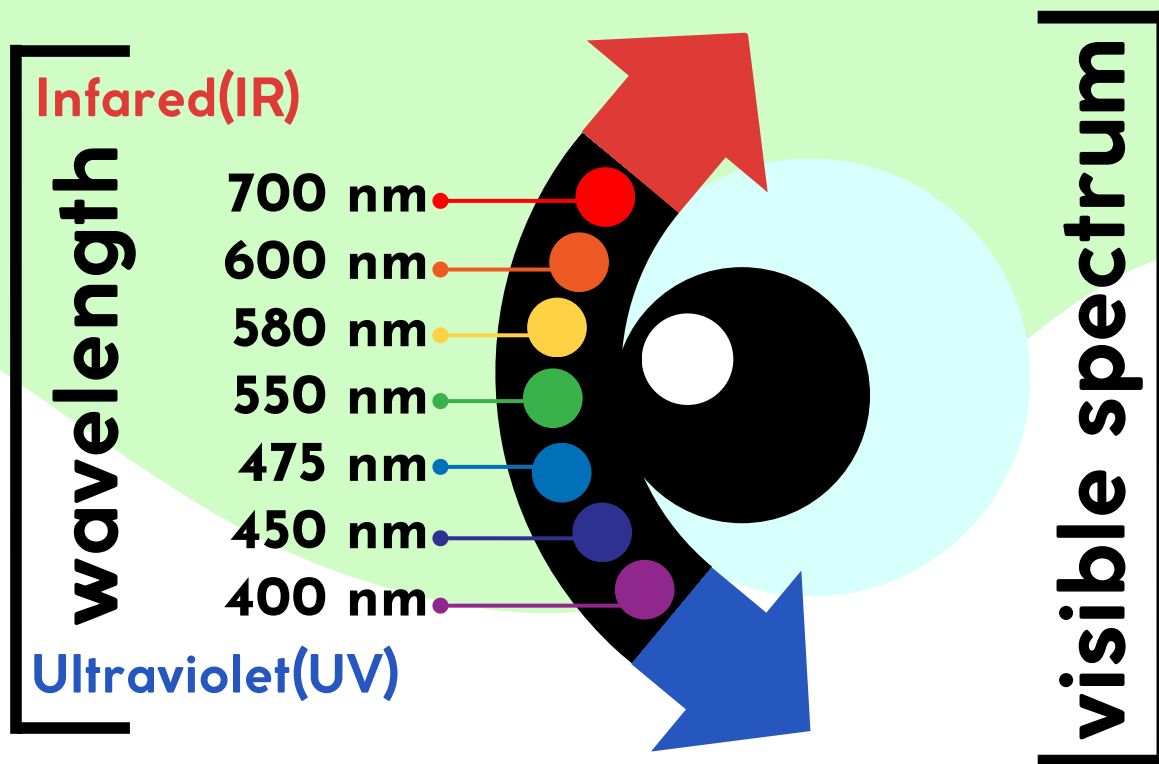
**P** RIMARY

**S** ECONDARY

**T** ERTIARY

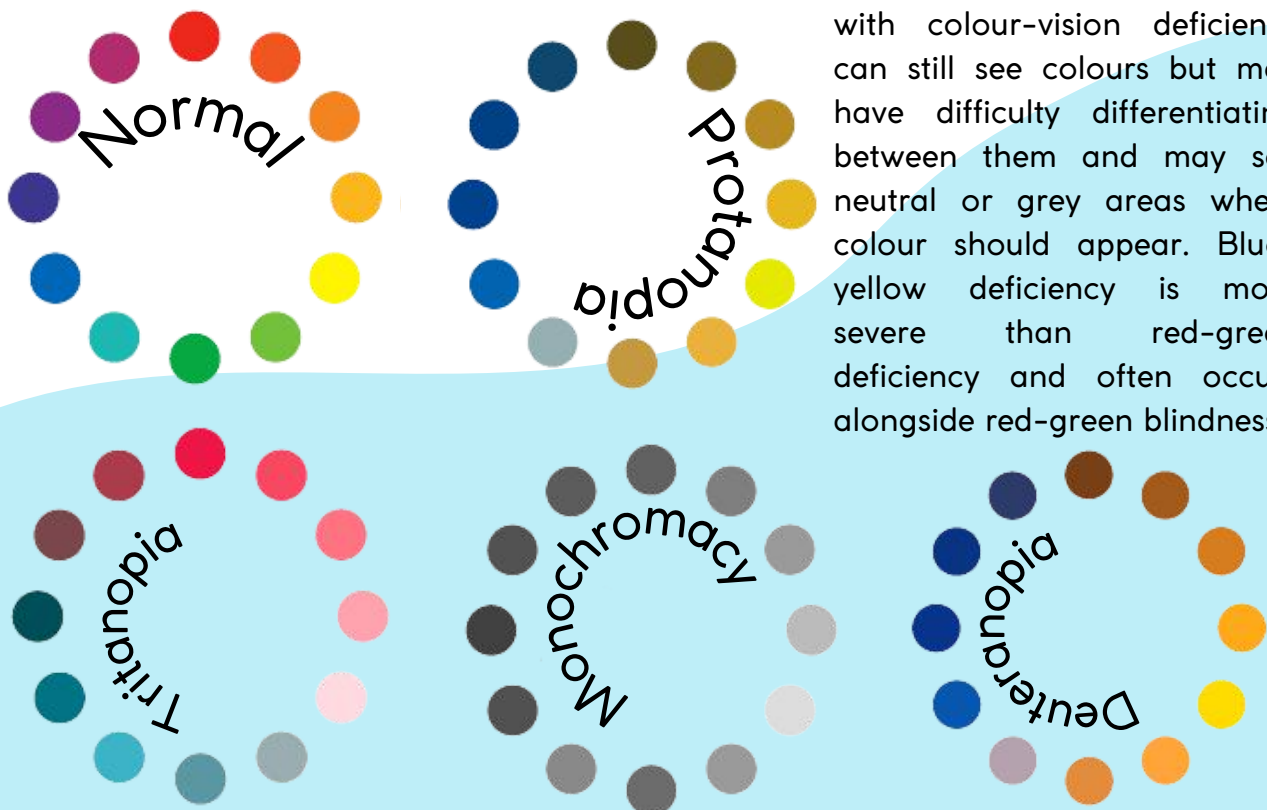


**The Science of Colour Perception:** The way our eyes and brains perceive colours and how colour vision works.

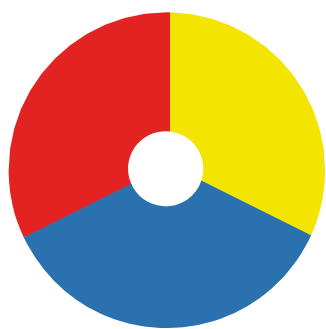


## COLOUR VISION DEFICIENCY

Colour vision deficiency is most commonly red-green, but there is also a rarer form called blue-yellow deficiency. People with colour-vision deficiency can still see colours but may have difficulty differentiating between them and may see neutral or grey areas where colour should appear. Blue-yellow deficiency is more severe than red-green deficiency and often occurs alongside red-green blindness.

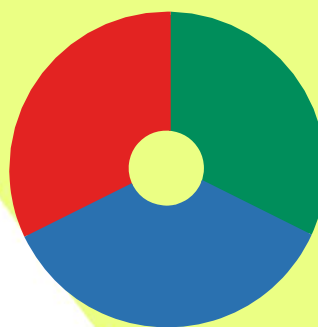






### Primary

Pigment generated colours are derived from the primary colours: red, yellow and blue



### Primary

Light generated colours are derived from the colours: red, green and blue

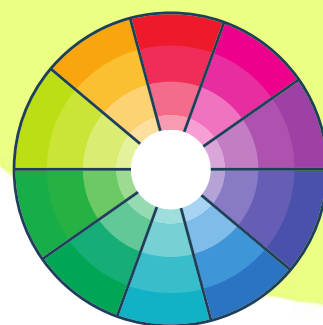
### Secondary

Mixing primary colours creates other colours. For example:  
blue+yellow=green  
blue+red=violet



### Tertiary and Beyond

A secondary colour wheel can expand to tertiary and beyond



## Colour Harmony



complimentary



analogous



triad



split complimentary



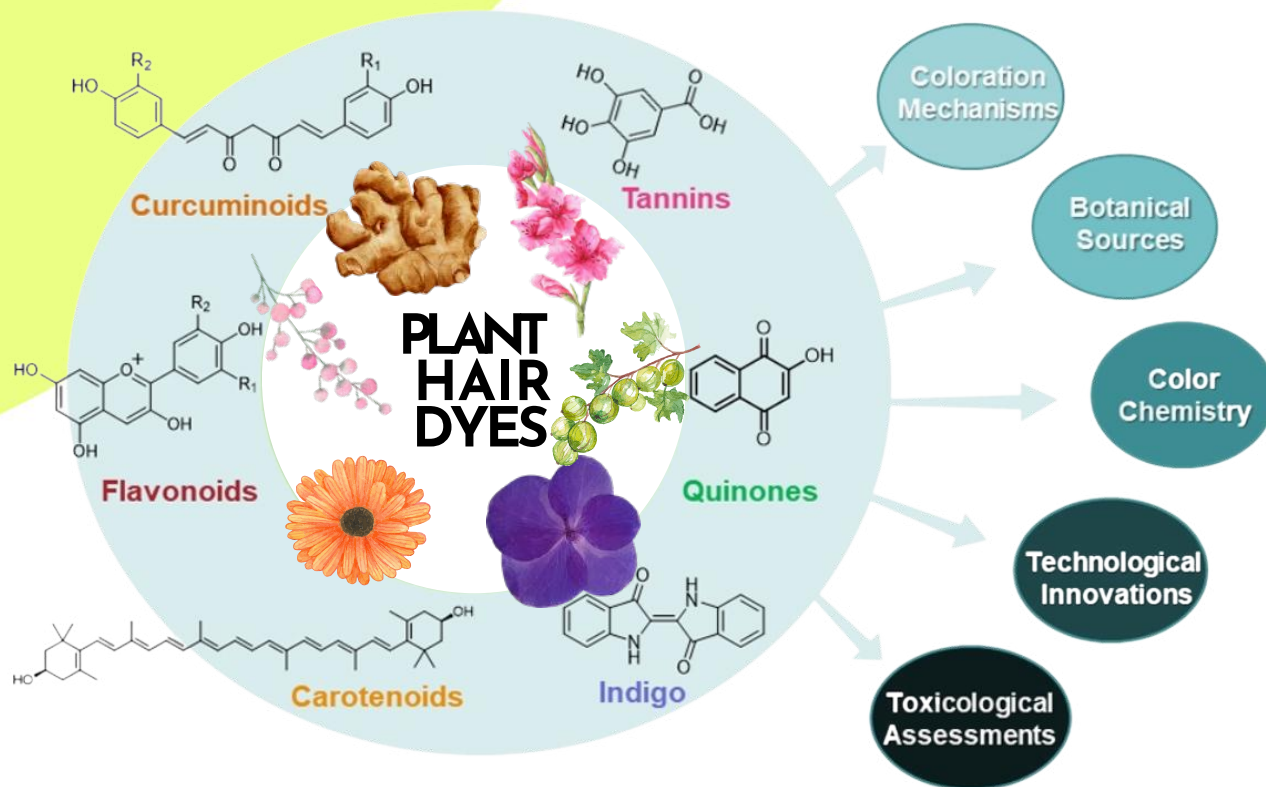
tetradic



quadrilateral

# ORGANIC & INORGANIC

The Palette of Chemistry: Revealing the Art and Science of Colour Pigments.



aluminium	bronze	pearlescent	phosphorescent

lead chromates	lead molybdates	Zn, Ba & Sr chromates

(Cd,Zn)S	cadmiums CdS	Cd(S,Se)/(Cd,Hg)S	zinc sulphide

cobalts	titanates	zinc ferrite	bismuth vanadate

titanium dioxide	chrome oxide	yellow	reds	brown	black

OTHERS

SALTS

METAL

OXIDES

METAL  
CHROMATES  
METAL  
SULPHIDESMIXED  
OXIDES  
METAL  
OXIDES



# COLOUR IN NATURE



PLANTS USE  
COLOUR TO  
ATTRACT  
POLLINATORS.



PLANTS THAT  
MIMIC ANIMALS



Source: <https://in.pinterest.com/pin/420734790179093706/>



# MESMERIZING COLOURS IN NATURE



Rainbow Eucalyptus



## **IMPACT** OF CLIMATE CHANGE ON THE COLOURS OF PLANTS.

**BEFORE  
BEFORE  
BEFORE  
BEFORE  
BEFORE**



**AFTER  
AFTER  
AFTER  
AFTER**



# MOOD AND PSYCHOLOGY

The use of colour can have a profound impact on our mood and mental health. From calming blues to energizing yellows, understanding the psychology of colour can help us make intentional choices that enhance our well-being.





# HEALTH

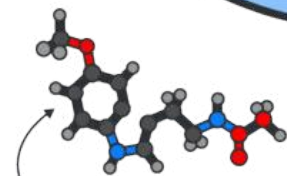
The disruption to your sleep schedule might leave you distracted and impair your **MEMORY** the next day.



A poor night's sleep caused by smartphone light can make it **HARDER TO LEARN**.



Over the long term, not getting enough sleep can lead to **NEUROTOXIN** buildup that makes it even harder for you to get good sleep.

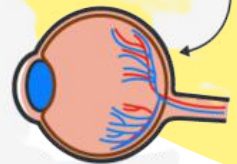


People whose melatonin levels are suppressed and whose body clocks are thrown off by light exposure are more prone to **DEPRESSION**.



By disrupting melatonin and sleep, smartphone light can also mess with the hormones that control hunger, potentially increasing **OBESITY RISK**.

There's some evidence that blue light could damage our vision by harming the **RETINA** over time – though more research is needed.



Researchers are investigating whether or not blue light could lead to **CATARACTS**.



There's a connection between light exposure at night and the disturbed sleep that come with it and an increased risk of breast and prostate **CANCERS**.



## Colour your plate!

### RED



MAINTAINS BLOOD PRESSURE  
CONTROLS TUMOR GROWTH  
REDUCES CHOLESTEROL  
REDUCES PROSTATE CANCER RISK  
PREVENTS ARTHRITIS

### ORANGE & YELLOW



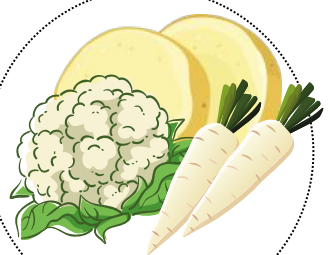
MAKES SKIN HEALTHY  
REDUCES PROSTATE CANCER RISK  
STRENGTHENS BONES AND JOINTS

### GREEN



LOWERS BLOOD PRESSURE  
REDUCES CANCER RISK  
REGULATES DIGESTION  
IMPROVES EYE HEALTH  
BOOSTS IMMUNITY

### WHITE



REDUCES RISK OF COLON, BREAST, PROSTATE AND HORMONE-RELATED CANCERS  
BALANCES HORMONE LEVELS

# DEMOGRAPHIC COLOUR PERCEPTION





# COLOUR PSYCHOLOGY

**12 colours** affect how we feel and act subconsciously. Here are its meaning and uses in art, design and life.

## INFLUENCE

COLOR IS THE FIRST THING PEOPLE WILL NOTICE ABOUT YOUR WORK OR PRODUCT.

STUDIES HAVE SHOWN THAT

**90%**

OF THE SNAP JUDGEMENTS ARE INFLUENCED BY THE COLOR ALONE.

## FACTS

FIRST COLOR THAT WE DISTINGUISH AFTER BIRTH IS COLOR RED, HOWEVER, COLOR BLUE IS THE FAVORITE ONE AMONG HUMANS WORLDWIDE.

PEOPLE WHO ARE COLD PREFER WARM COLORS LIKE RED AND YELLOW WHILE PEOPLE WHO ARE HOT PREFER COOL COLORS LIKE BLUE AND GREEN.

THE LOWER THE MEAN SATURATION OF SUBJECT, THE MORE COMFORT IS FELT WHEN BEING AROUND IT.

## PROPERTIES

### COLOR

COLOR IS PROPERTY POSSESSED BY ANY OBJECT. EACH OBJECT REFLECTS OR EMITS LIGHT AND IS PRODUCING DIFFERENT SENSATIONS ON THE EYE. OBJECTS REFLECT LIGHT IN DIFFERENT WAVELENGTHS WHICH WE RECOGNIZE AS COLOR.

COLOR	WAVELENGTH
RED	700 - 635 nm
ORANGE	635 - 590 nm
YELLOW	590 - 560 nm
GREEN	560 - 520 nm
CYAN	520 - 490 nm
BLUE	490 - 450 nm
VIOLET	450 - 400 nm

### COLOR PROPERTIES

COLOR PROPERTIES ALLOW US TO DISTINGUISH AND DEFINE COLORS.

HUE IS ACTUAL COLOR OR COMBINATION OF COLORS (RED, YELLOW, ORANGE)



VALUE IS HOW LIGHT OR DARK IS IT (TINTS AND SHADES)



CHROMA POINTS TO THE COLOR'S INTENSITY OR SATURATION.



## EMOTION

## INDUSTRY

## USED TO

RED	EXCITEMENT ENERGY PASSION COURAGE ATTENTION	ENTERTAINMENT FOOD SPORT FIRE PROTECTION CHILDREN PRODUCTS	STIMULATE CREATE URGENCY DRAW ATTENTION CAUTION ENCOURAGE
ORANGE	OPTIMISTIC INDEPENDENT ADVENTUROUS CREATIVITY FUN	ART ENTERTAINMENT FOOD SPORTS TRANSPORTATION	STIMULATE COMMUNICATE FUN DRAW ATTENTION EXPRESS FREEDOM FASCINATE
YELLOW	ENTHUSIASM OPPORTUNITY SPONTANITY HAPPINESS POSITIVITY	FOOD SPORTS TRANSPORTATION TRAVEL LEISURE	STIMULATE ENCOURAGE RELAXATION AWAKE AWARENESS ENERGIZE AFFECT MOOD
LIME GREEN	GROWTH HARMONY FERTILITY KINDNESS DEPENDABILITY	ENVIRONMENT LEISURE ALTERNATIVE ENERGY ENTERTAINMENT EDUCATION	RESTORE ENERGY PROMOTE GROWTH NUTURE REJUVENATE
KELLY GREEN	SAFETY HARMONY STABILITY RELIABILITY BALANCE	ENVIRONMENT BANKING REAL ESTATE FARMING NON PROFIT	RELAX BALANCE REVITALIZE ENCOURAGE POSSESS
SKY BLUE	FREEDOM SELF EXPRESSION TRUSTWORTH WISDOM JOY	ENTERTAINMENT COMMUNICATION CHILDRENS PRODUCTS TECHNOLOGY AEROSPACE	DRAW ATTENTION INSPIRE TRUST SUGGEST PRECISION COMMUNICATE CONSCIOUSNESS STIMULATE PRODUCTIVITY
ROYAL BLUE	TRUST RESPONSIBILITY HONESTY LOYALTY INNER SECURITY	SECURITY FINANCE TECHNOLOGY HEALTH CARE ACCOUNTING	REDUCE STRESS CREATE CALMNESS RELAX SECURE CREATE ORDER
VIOLET	IMAGINATION SPIRITUALITY COMPASSION SENSIVITY MYSTERY	HUMANITARIAN PSYCHIC RELIGION	ENCOURAGE CREATIVITY INSPIRE COMBINE WISDOM AND POWER CREATE IMPRESSION OF LUXURY INTUITION
PINK	COMPASSION LOVE IMMATURE PLAYFUL ADMIRATION	CHILDRENS PRODUCTS WOMANS PRODUCTS BEAUTY FASHION	COMMUNICATE ENERGY INCREASE PULSE MOTIVATE ACTION FASCINATE ENCOURAGES CREATIVITY
BROWN	RELIABILITY STABILITY HONESTY COMFORT NATURAL	AGRICULTURE CONSTRUCTION TRANSPORTATION LEGAL FOOD	STABILIZE IMPLY COMMON SENSE SUPPRESS EMOTIONS CREATE WARMTH
GRAY	NEUTRAL PRACTICAL CONSERVATIVE FORMAL QUIET	ALL INDUSTRIES * MOSTLY USED IN COMBINATION WITH OTHER COLORS	CREATE SENSE OF COMPOSURE DEPRESS ENERGY ASSOCIATE TIMELESS COMMUNICATE MATURATION
BLACK	POWER CONTROL AUTHORITY DISCIPLINE ELEGANCE	ALL INDUSTRIES * MOSTLY USED IN COMBINATION WITH OTHER COLORS	HIDE FEELINGS INTIMIDATE RADIATE AUTHORITY CREATE FEAR ASSOCIATE WITH MYSTERY



# COLOUR & CREATIVITY

Ways in which colour inspires and influences creative expression.





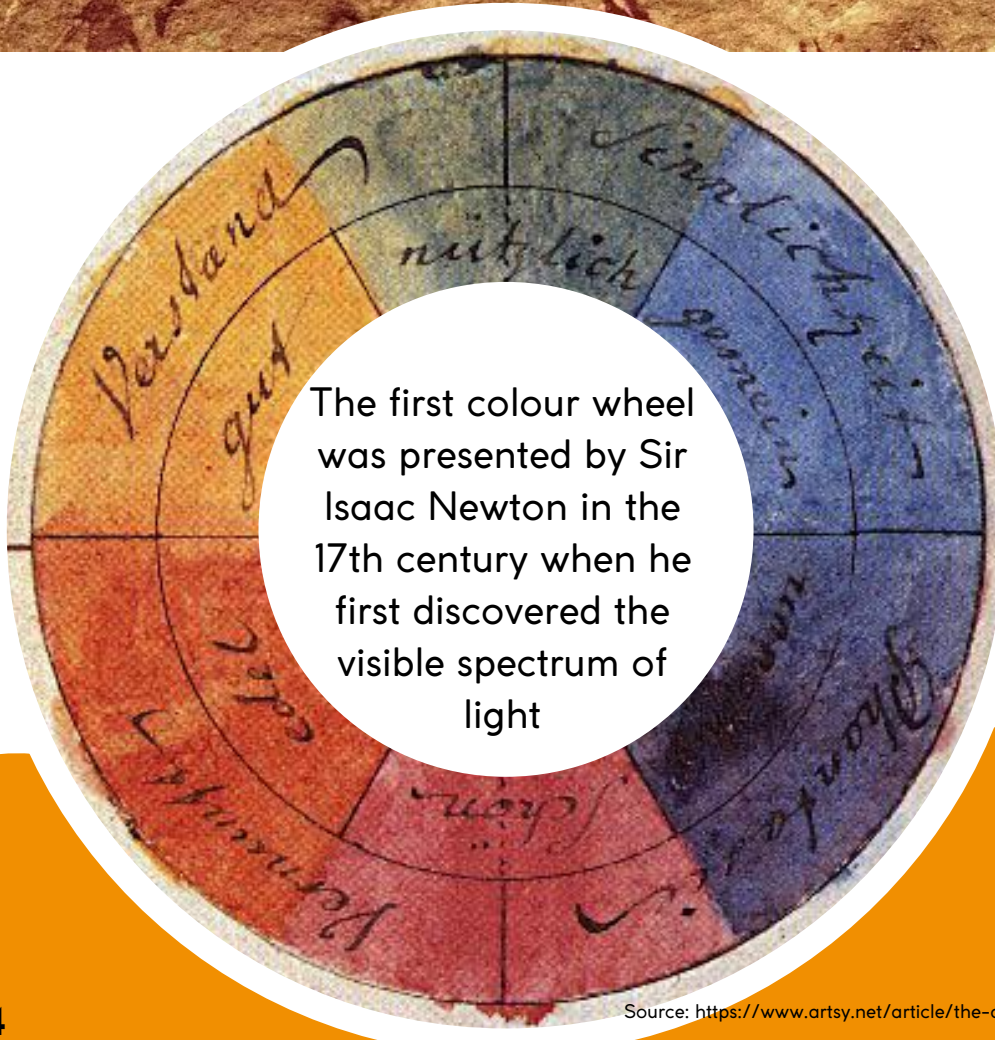
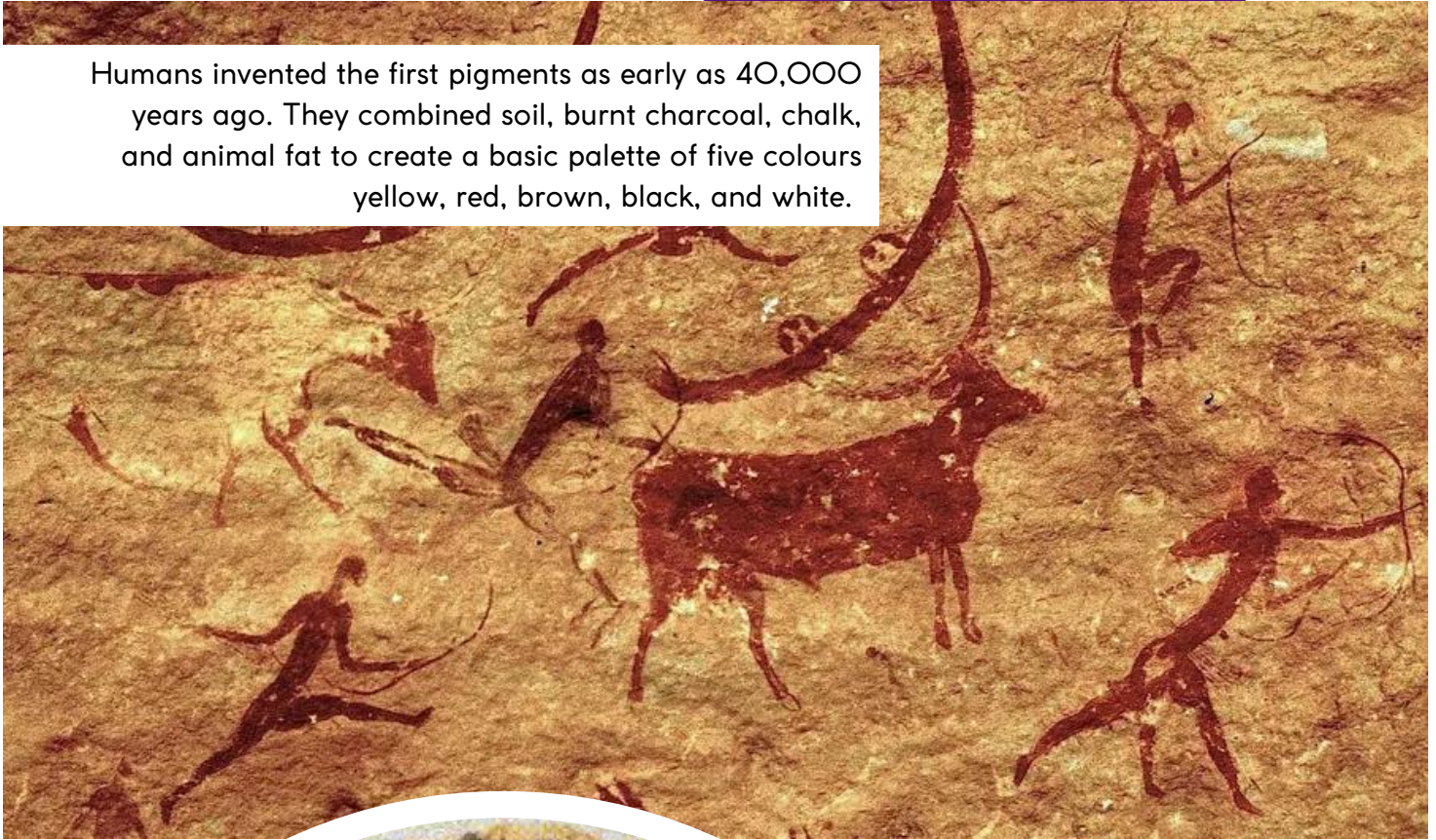
# COLOUR & CLOTH

Transform your outlook on life with the transformative power of colour. Tap into the energy of different hues to enhance your mood, boost your confidence, and cultivate a positive mindset.



# HISTORY

Humans invented the first pigments as early as 40,000 years ago. They combined soil, burnt charcoal, chalk, and animal fat to create a basic palette of five colours yellow, red, brown, black, and white.



The first colour wheel was presented by Sir Isaac Newton in the 17th century when he first discovered the visible spectrum of light

Vibrant colours and dynamic scenes represent mystic legends of gods and goddesses in Hinduism painting in India



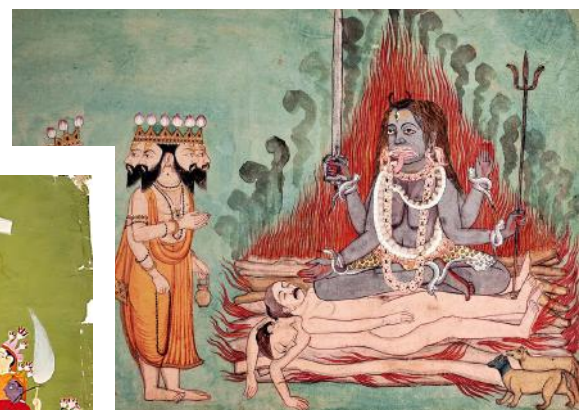
# IN ANCIENT INDIA

The word *chakra* comes from the Sanskrit (sacred Hindu language), and it literally means “wheel of light”. Chakras can be described as colourful vortexes of energy that constantly spin like wheels at different speeds.

## CHAKRA COLORS CHART

VIOLET WHITE	DARK BLUE INDIGO	LIGHT BLUE	GREEN	YELLOW	ORANGE	RED
						
SAHASRARA	AJNA	VISHUDDHA	ANAHATA	MANIPURA	SVADHISHTHANA	MULADHARA
CROWN CHAKRA	THIRD EYE CHAKRA	THROAT CHAKRA	HEART CHAKRA	SOLAR PLEXUS CHAKRA	SACRAL CHAKRA	ROOT CHAKRA

The text *chitrasutra* mentions five basic colours, while the others only have four (red, yellow, blue and white), though both agree on white as a primary colour.





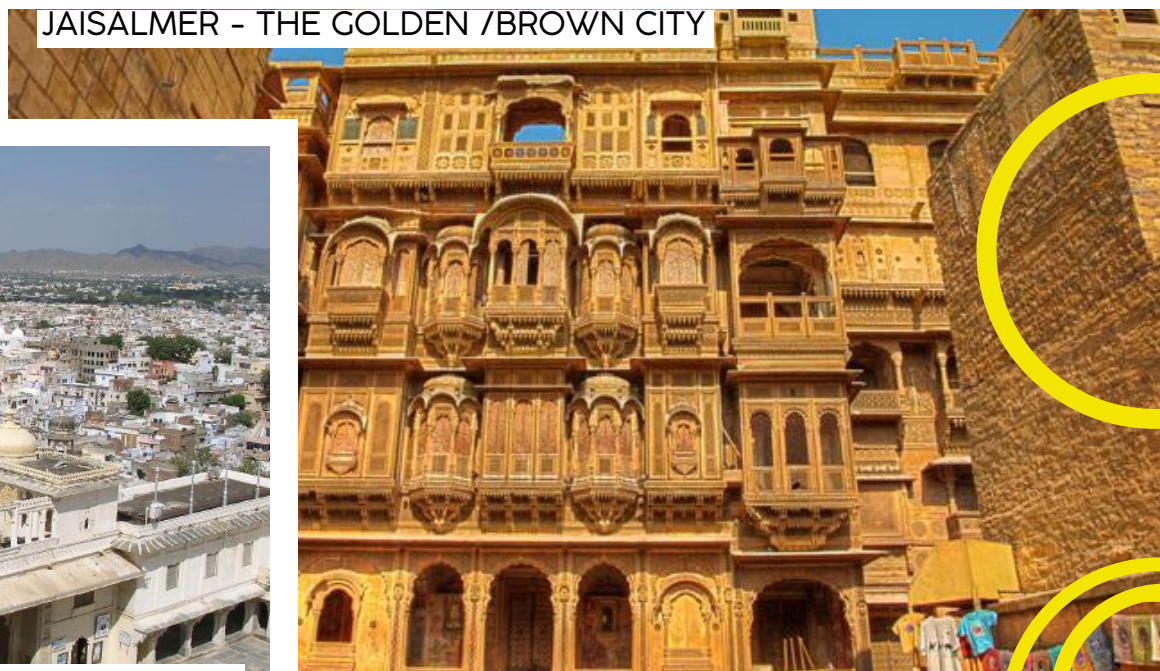
# VIBRANT CITIES OF INDIA



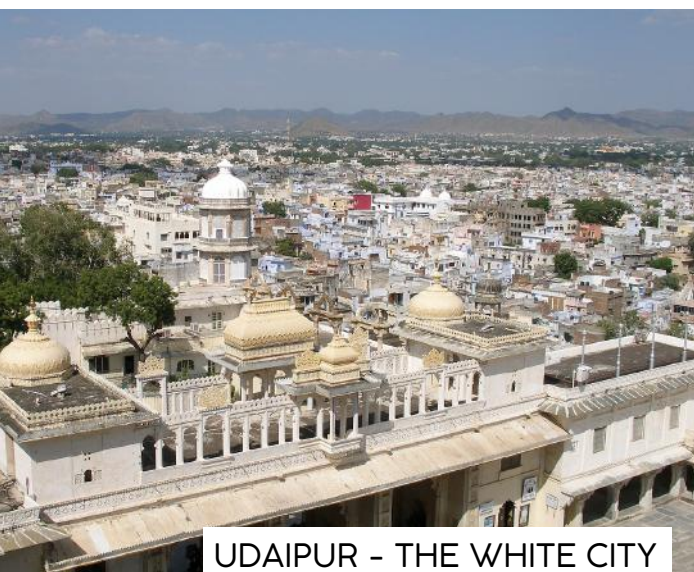
JAIPUR - THE PINK CITY



JODHPUR - THE BLUE CITY



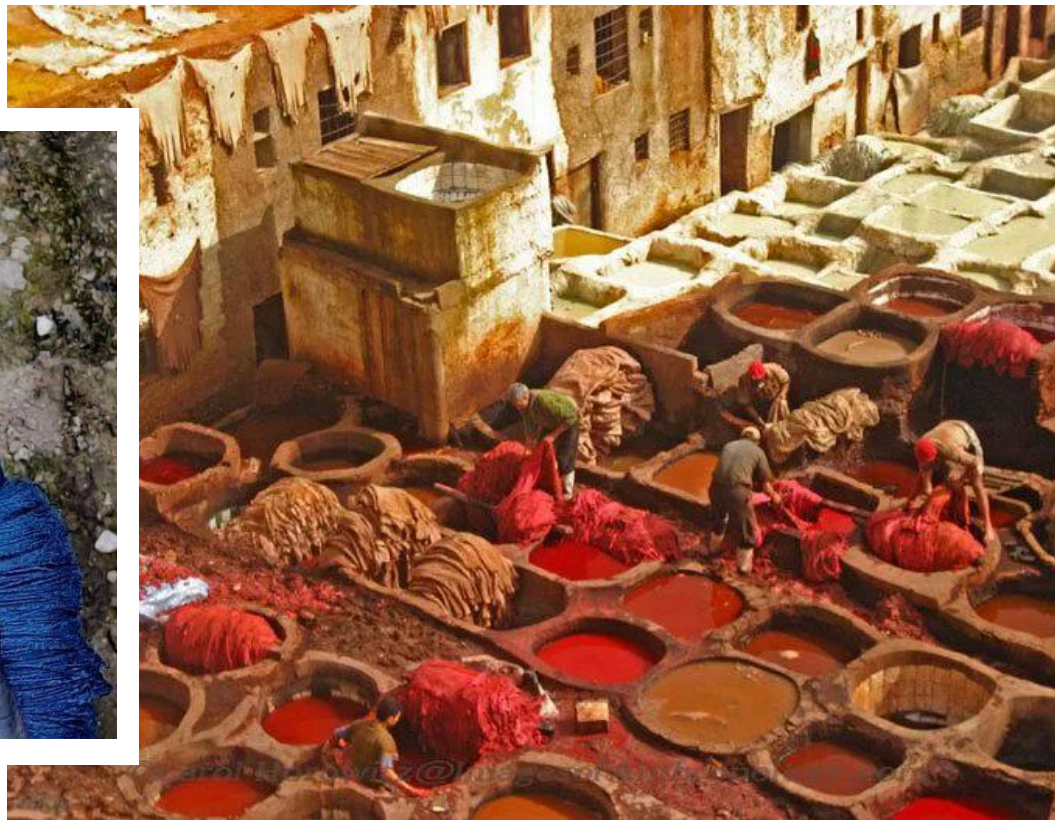
JAISALMER - THE GOLDEN /BROWN CITY



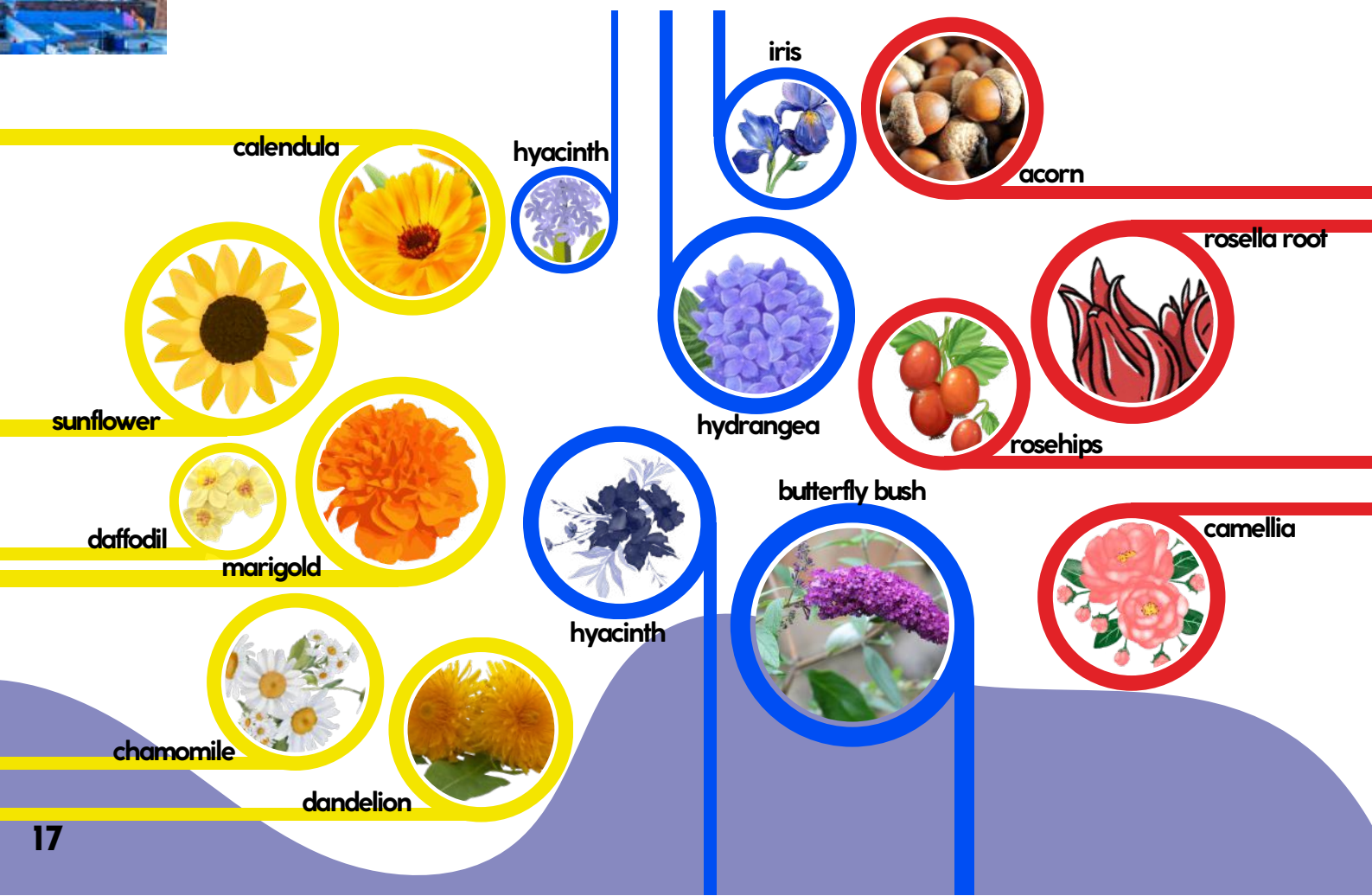
UDAIPUR - THE WHITE CITY



# COLOUR PREPARATION



## PLANT BASED TEXTILE DYES



# CHALLENGES

SAY THE  
COLOUR  
YOU SEE  
IN THE  
WORDS  
→ NOT  
THE  
TEXT AS  
FAAFAST  
AS YOU  
CAN

**GREEN** **BROWN**

**RED** **PINK**

**BLUE** **PURPLE**

**TAN** **YELLOW**

**WHITE** **BLACK**

**ORANGE** **GREY**

YOUR RIGHT  
BRAIN TRIES TO SAY  
THE COLOUR BUT  
YOUR LEFT BRAIN  
INSISTS ON READING  
THE WORD.

THIS MONTH'S CHALLENGE:

**"Create your own colour"**

—Come up with a new colour of your own which does not exist. It's time to pick up some colours and start creating.

SEND IN YOUR ANSWERS TO  
[content@paraminnovation.org](mailto:content@paraminnovation.org)



# FACTS

1

There Is a **colour** You **CAN'T** See: The newly invented **VANTABLACK** is so dark, it appears to be a black hole!

2

**EIGENRAU** is the dark grey colour perceived by the human eye in the absence of light.

3

The **SUN is white** when viewed from space. The Earth's atmosphere makes it appear to be yellow.

4

The colour **orange** was named after the fruit. Before its name change, it was known in English as "**GEOLUHREAD**"

# and

# SNIPPETS

The human eye can see about **10 million** colours

5

**ORANGE** colour was referred to either as a hue of red or yellow.

6

**Red and Yellow** stimulate **Hunger**

7

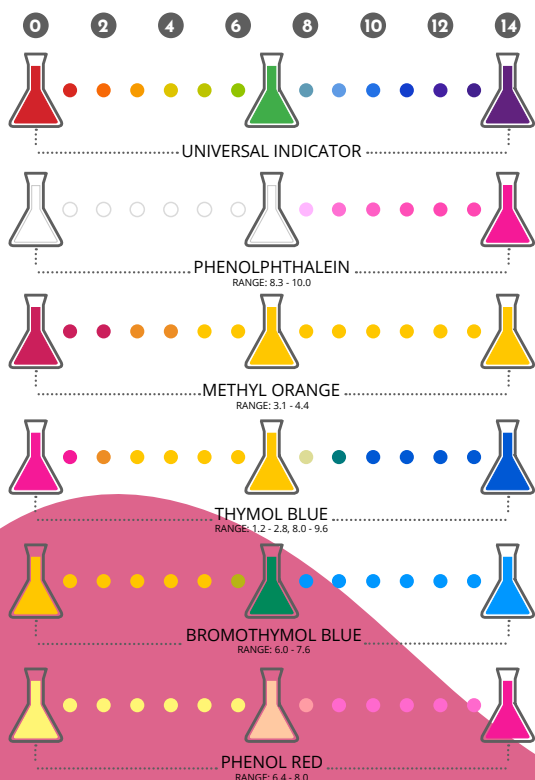
**Red** is the First Colour **A Baby** Sees!

8

# CHEMISTRY OF COLOUR

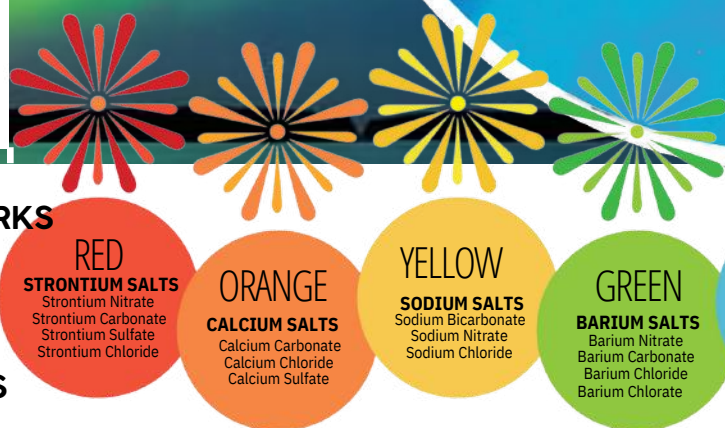
The **Aurora Borealis** occur when charged particles (electrons and protons) collide with gases in Earth's upper atmosphere. Those collisions produce tiny flashes that fill the sky with colourful light. As billions of flashes occur in sequence, the auroras appear to move or "dance" in the sky.

## COLOURS OF PH INDICATORS

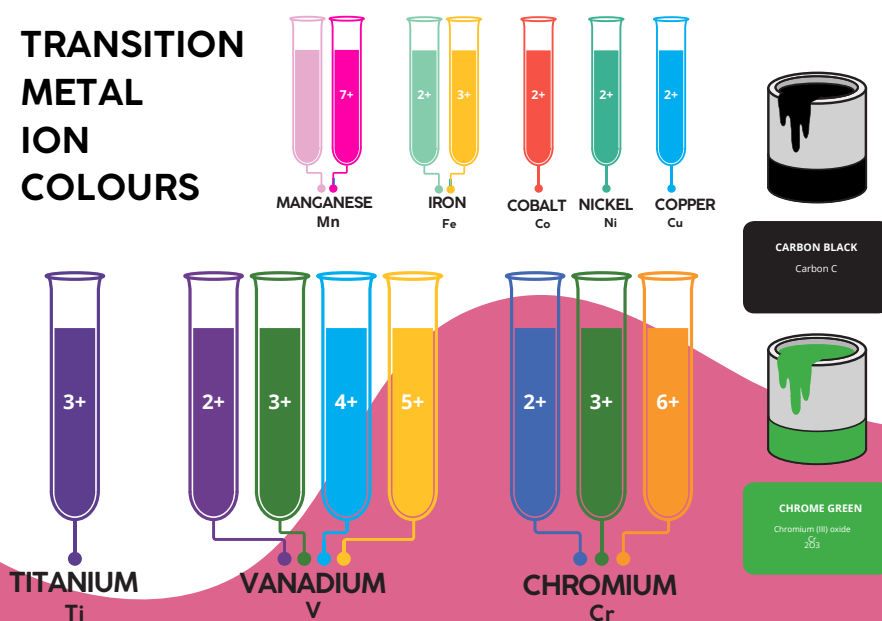


## FIRE WORKS

**& COLOURS**



## TRANSITION METAL ION COLOURS





# BIOLUMINESCENT ORGANISMS



## METAL ION FLAME TESTS

**PIGMENTS IN PAINTS**

**BLUE**  
COPPER SALTS  
Copper (I) Chloride  
Copper Carbonate  
Copper Oxides

**PURPLE**  
COMBINE COPPER & STRONTIUM COMPOUNDS

**SILVER**  
WHITE HOT  
MAGNESIUM & ALUMINIUM

**WHITE**  
BURNING METAL  
Magnesium  
Aluminium  
Titanium

**TITANIUM WHITE**  
Titanium dioxide, TiO<sub>2</sub>

**ANTIMONY WHITE**  
Antimony trioxide

**ZINC WHITE**  
Zinc Oxide, ZnO

**COBALT VIOLET**  
Cobalt (II) phosphate

**ULTRAMARINE BLUE**  
Na<sub>6</sub>Al<sub>3</sub>(Si<sub>6</sub>Al<sub>2</sub>)O<sub>20</sub>

**PRUSSIAN BLUE**  
Ferric hexacyanoferrate, Fe(CN)<sub>6</sub>

**COBALT BLUE**  
Cobalt (II) aluminate

**CERULEAN BLUE**  
Cobalt (II) stannate  
2 SnO<sub>2</sub> · 3 CoO

**VIRIDIAN GREEN**  
Hydrated chromium (III) oxide  
Cr<sub>2</sub>O<sub>3</sub> · (OH)<sub>4</sub>

**CADMIUM YELLOW**  
Cadmium sulfide, CdS

**CHROME YELLOW**  
Lead chromate, PbCrO<sub>4</sub>

**ZINC YELLOW**  
Zinc chromate, ZnCrO<sub>4</sub>

**CADMIUM ORANGE**  
Cadmium selenosulfide  
CdSeS

**CADMIUM RED RED**  
Cadmium selenide, CdSe

**OGRE**  
Iron (III) oxide, Fe<sub>2</sub>O<sub>3</sub>

**LITHIUM**  
Li<sup>+</sup>

**SODIUM**  
Na<sup>+</sup>

**POTASSIUM**  
K<sup>+</sup>

**RUBIDIUM**  
Rb<sup>+</sup>

**CAESIUM**  
Cs<sup>+</sup>

**CALCIUM**  
Ca<sup>2+</sup>

**STRONTIUM**  
Sr<sup>2+</sup>

**BARIUM**  
Ba<sup>2+</sup>

**RADIUM**  
Ra<sup>2+</sup>

**COPPER**  
Cu<sup>2+</sup>

**IRON**  
Fe<sup>2+</sup>/Fe<sup>3+</sup>

**BORON**  
B<sup>3+</sup>

**INDIUM**  
In<sup>3+</sup>

**LEAD**  
Pb<sup>2+</sup>

**ARSENIC**  
As<sup>3+</sup>

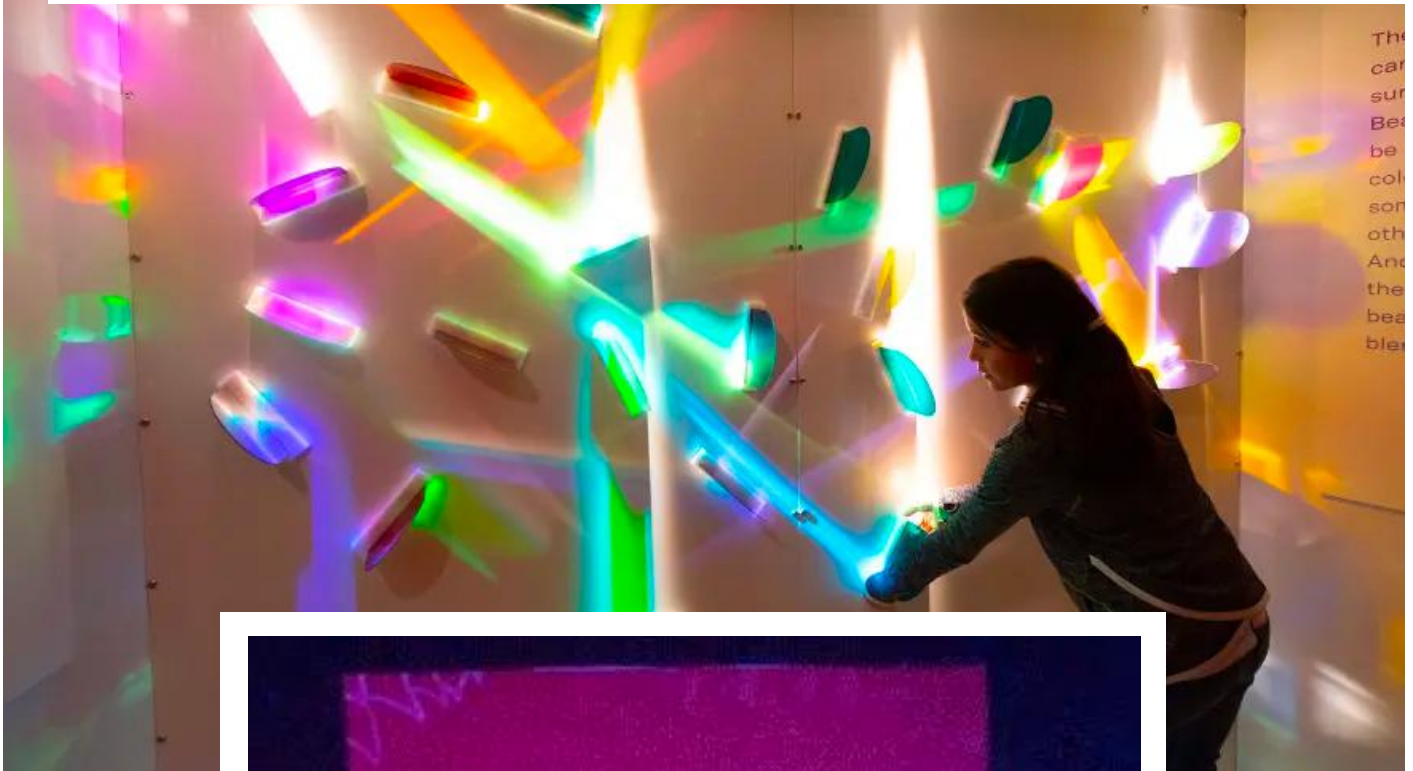
**ANTIMONY**  
Sb<sup>3+</sup>/Sb<sup>5+</sup>

**SELENIUM**  
Se<sup>2+</sup>/Se<sup>4+</sup>

**ZINC**  
Zn<sup>2+</sup>

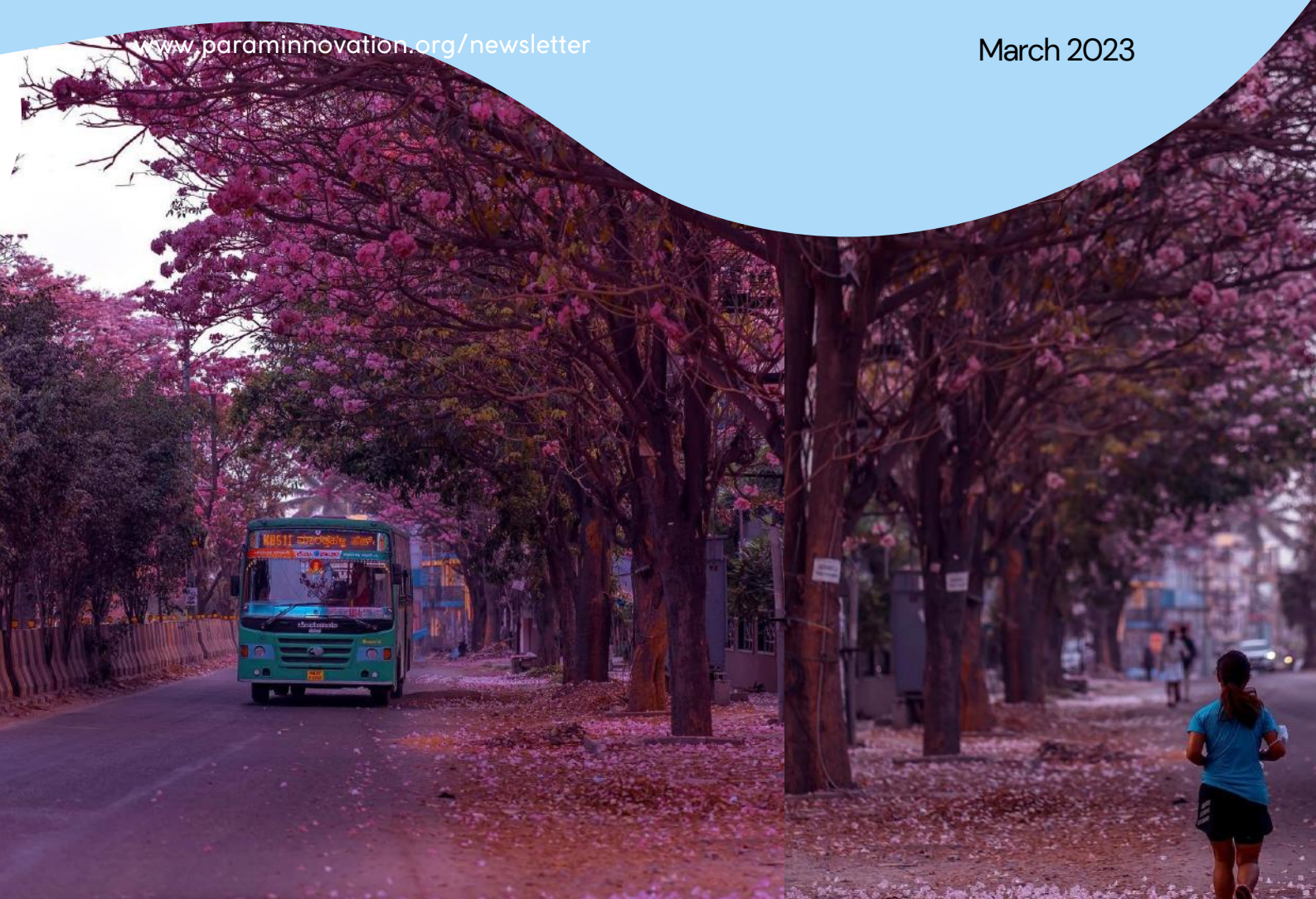
# EXHIBIT OF THE MONTH

This Exhibit shows how objects can produce colour in many different ways, depending on how they interact with light, and how people have searched for pigments and dyes to make their lives more colourful.



This is an interactive art called the colorizer which makes art appear to move, shift and change colour.





## COLOURFUL BANGALORE

**Cherry trees bloom** as a result of physiological changes in plants brought on by a combination of rising temperatures and longer days. Genetics, location, and environmental conditions can all have an impact on when a plant blooms. Cherry blossoms come from a neotropical tree called **Tabibuea Rosea**.





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