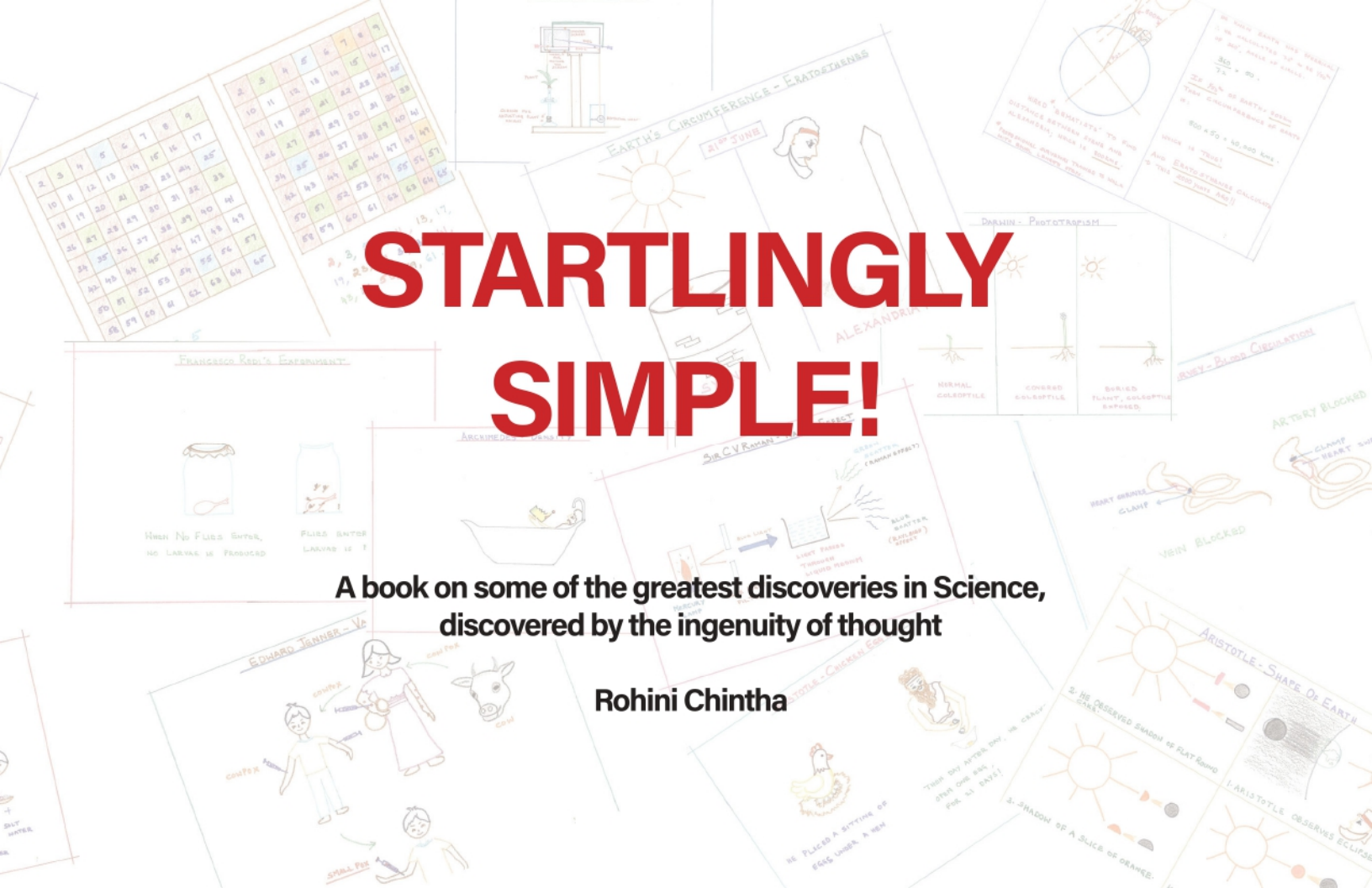

STARTLINGLY SIMPLE!

A book on some of the greatest discoveries in Science, discovered by the ingenuity of thought

Rohini Chintha

Startlingly Simple!

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Copies: 2000
April 2025
Not for Sale

Published by
BASIC RESEARCH, EDUCATION AND DEVELOPMENT SOCIETY
Hyderabad 500 033
Ph: +91 93421 09434
Email: breadsociety@gmail.com
Website: https://www.breadsocietyindia.org

Printed at
MUDRICA Offset & Digital Printers
40-5/6-3, Acharya Ranga Nagar
Near Benz Circle, Vijayawada 520 010
Ph: +91 99890 83870, +91 90631 59456
Email: moffset@gmail.com

Startlingly Simple!

A book on some of the greatest discoveries in
Science, discovered by the ingenuity of thought

Rohini Chintha

Dedicated
to
BASHI
who kindles my imagination

Foreword

Books on scientific discoveries are plenty. But, unlike most other children's science books, this book is not another effort to tell science stories, nor to show pretty pictures of plants and animals. This book aims to impress young minds that science is borne out of child-like curiosity and a daring to think differently.

In this book, Dr Rohini Chintha, a well-known science storyteller who has posted a large number of short video bytes on fundamental experiments in science, explains some of the major discoveries in a way that is easy for young children to understand. The book comes with creative illustrations, hand-drawn by Dr Chintha herself as an artist, making the scientific concepts easy to understand. The book, by design, doesn't follow any specific theme. Not all major discoveries are covered. While stories are arranged in a chronological order, purpose is to showcase to young minds that scientific discoveries, no matter how earth-shaking, are borne out of people who asked the right question, formulated simple hypothesis, made unbiased observations and, were validated by ingenious experimental methods, which are in-expensive. Take home message to all children from each story, "I can also become a scientist. I can also discover".

Awareness of science and its significance in shaping our societies, the importance of developing scientific temperament, and developing analytical and critical thinking abilities are very much needed in an increasingly divisive world besieged by conflicts and climate change. Children start learning from the day they are born. But, their education starts much later, and conceptual understanding of science doesn't start until very late.

This book, appropriately titled as STARTLINGLY SIMPLE!, is an attempt in right direction and I am confident it will appeal to children of all ages. More than congratulating Dr Chintha for producing this book, I thank her on behalf of all of us in the society for giving us a much-needed book to educate our children and grandchildren.

LS Shashidhara FASc FNASc FNA

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Have you ever looked up at the sky on a full moon night and wondered where the Moon gets its pleasant glow from? Have you ever wondered what the shape of the Earth you stand on is and how it has been deduced? Or how they determined the size of the Earth? Have you wondered about the things around you?

Our ancestors wondered too and wondered till their curiosity got the better of them. And out of their curiosity was born science. They formed ideas about the things around them and came up with startlingly simple experiments to prove those ideas. The experiments that changed the way we perceive the world of science. The experiments that provided an answer to some of the 'why, what and how' that haunt the human mind. Experiments that paved the way for branches of science like 'Astronomy, Embryology, Genetics, Microbiology, Geoscience, Geography, Optics and Clinical studies', to develop into independent fields. Answers that were found, not in sophisticated science laboratories, but in everyday settings like barns and backyards.

A few such startlingly simple yet pathbreaking science experiments, all loosely connected under 'the few firsts of science' are recorded here.

Experiments from THE B.C.E

Few Firsts in Astronomy, Embryology, Geoscience, Physics and Mathematics

Astronomy | 450 BCE

Anaxagoras - Moonlight is reflected sunlight

Till 450 BCE, it was believed that the Sun and the Moon are heavenly bodies and that the Moon had a light of its own.

Anaxagoras hypothesised that the Moon is just a rock and has no light of its own.

The Question : Does the Moon really have a light of its own?

Anaxagoras's thought experiment provided the answer.

Anaxagoras

- 500-428 BCE
- Greek philosopher
- Contributed to the fields of: Philosophy, Mathematics, Astronomy

Astronomy | 450 BCE

Anaxagoras - Moonlight is reflected sunlight

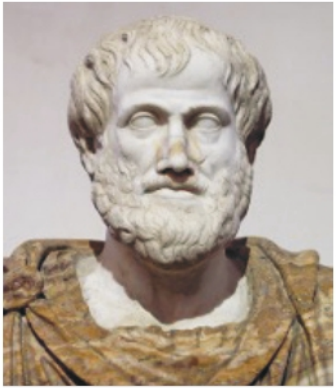
- Anaxagoras observed that ‘full moon’ is seen only when the Sun and the Moon are on opposite sides of the Earth.
- He also observed that during a solar eclipse, sunlight is blocked by the Moon, as the Moon comes between the Sun and the Earth. Hence day on the Earth appears dark.
- If the Moon had light of its own, Anaxagoras reasoned, then moonlight would still shine on the Earth during the solar eclipse, despite sunlight being blocked, and the day on Earth would appear bright!
- But during a solar eclipse, only the corona of the Sun is seen and day on the Earth is dim because the Moon has no light of its own!

So?

- Moon, a rock, shines because it reflects sunlight falling on it. Moonlight is reflected sunlight!
- Anaxagoras used: Eyes and Brain!

Embrology | 350 BCE

Aristotle - Chicken eggs experiment



During Aristotle's time, people thought that ready-made mini babies (pre-formed) are given by the father. And that the mother only provides space for these mini babies to grow. But, Aristotle didn't believe this and proposed that babies are formed gradually from the fertilized egg. They are not given ready-made/pre-formed by the father.

The Question : Are ready-made mini babies passed on by the father or do babies gradually develop from the fertilized egg?

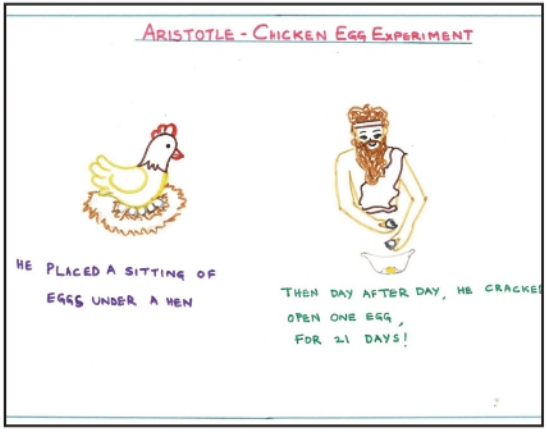
Aristotle provided the answer through his simple experiment.

Aristotle

- Lived: 384-322 BCE
- Greek Philosopher, Free thinker, Polymath
- Contributed to the field of Botany, Zoology, Physics, Geology, Philosophy, Logic, Astronomy, Embryology....to name a few.
- Teacher of Alexander, the great!
- Father of Embryology, Father of Scientific Method

Embrology | 350 BCE

Aristotle - Chicken egg experiment



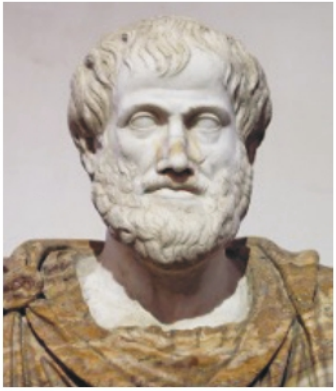
- Aristotle took a lot of chicken eggs of approximately the same age and put them under a hen to hatch.
- Everyday he picked one egg and broke it open. He saw that the heart formed first, then the eyes. Slowly, after that, formed the other organs. Finally, by the 10th day, the whole chick is formed! Then the baby chick grows in size till the 21st day and, it then hatches to comes out!

So?

- If the father gave a ready-made mini baby, it should be there when the egg was broken on the first day itself! But mini baby appeared on the 10th day, proving that babies form gradually! He became the father of 'Embryology' with this experiment!
- Aristotle used: Chicken eggs and Brain!

Geoscience | around 350 BCE

Aristotle - Shape of the Earth



For centuries, people around the world thought that the Earth was flat. But then, nobody knew for sure.

Many ancient thinkers wondered about the shape of the Earth and so did Aristotle.

The Question : What is the shape of planet Earth?

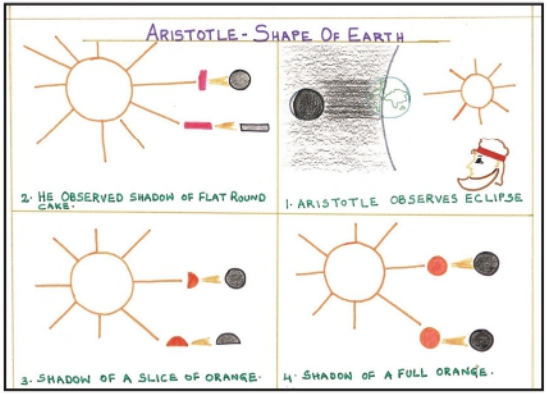
Aristotle's elegantly simple experiment provided the answer long before satellite images!

Aristotle

- Lived: 384-322 BCE
- Greek Philosopher, Free thinker, Polymath
- Contributed to the field of : Botany, Zoology, Physics, Geology, Philosophy, Logic, Astronomy, Embryology....to name a few
- Teacher of Alexander, the great!
- Father of Embryology, Father of Scientific Method

Geoscience | around 350 BCE

Aristotle - Shape of the Earth



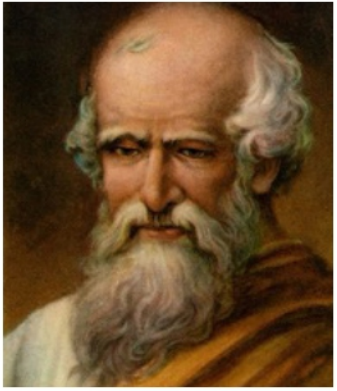
- Aristotle observed that during a lunar eclipse the shadow cast by the Earth on the Moon was always circular.
- Aristotle took a flat, round cake and held it against light. In one angle the shadow was round but in another, the shadow was flat.
- He then held half an orange against light. In one angle, its shadow was round, but in another, it was a semicircle.
- He then held a full orange against light. No matter how he held it, the shadow was always round, just like the Earth's shadow on the Moon! Only a round object casts a circular shadow always!

So?

- Aristotle proved that the Earth was round by observing shadows!
- Aristotle used: Flat round cake, a full orange and a half orange slice.

Physics | 246 BCE

Archimedes discovers laws of buoyancy



Legend says that Archimedes ran naked through the streets of Syracuse shouting, 'Eureka' (Greek for 'I found it')

Without melting or de-shaping the crown, he found that a gold crown was not made of pure gold!

The Question: At a time when there were no instruments available to facilitate accurate measurement, how could one determine the purity of a metal object?

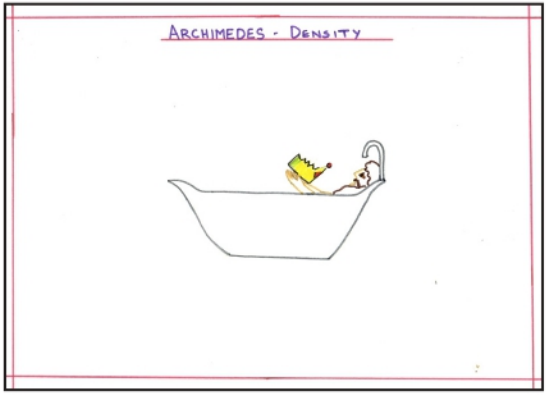
Archimedes, using spilled water, discovered specific gravity and laws of buoyancy, and a method to assess purity of metals!

Archimedes

- 287-212 BCE
- Greek Mathematician, Inventor
- Contributed to fields of : Mathematics, Physics, Astronomy, Engineering
- Known for value of Pi, Archimedes screw and Eureka!

Physics | 246 BCE

Archimedes discovers Laws of Buoyancy



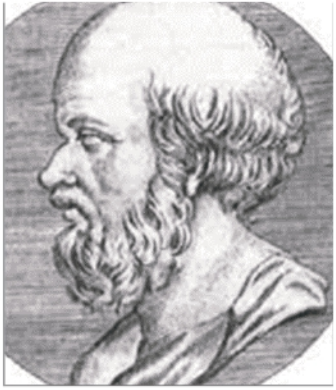
- Archimedes filled a beaked bowl to the very brim with water.
- He placed the crown gently in the water. He collected the water displaced/spilled by the crown in a cup till there was no spillage.
- He first measured the weight of the empty cup and then measured the weight of water filled cup using a balance. He got the weight of the displaced water by subtraction.
- Same was repeated using a pure gold chunk weighing same as gold given by the king to the goldsmith.
- Archimedes discovered that the weight of water displaced by the object (water displaced by crown) equals the weight of the object (crown); and that the gold crown and pure gold weighed different.

So?

- Using this experiment, Archimedes proposed 1. laws of buoyancy and 2. method to calculate specific gravity (and thereby, density).
- Archimedes used: Water in a bowl, cups and a balance.

Geography | 240 BCE

Eratosthenes - the circumference of the Earth



Early Greek philosophers wondered about how big the Earth was and if there was a way to measure its size. But how can one measure something that cannot be seen completely or held. But their curiosity kept driving them.

The question: What is the size of the Earth?

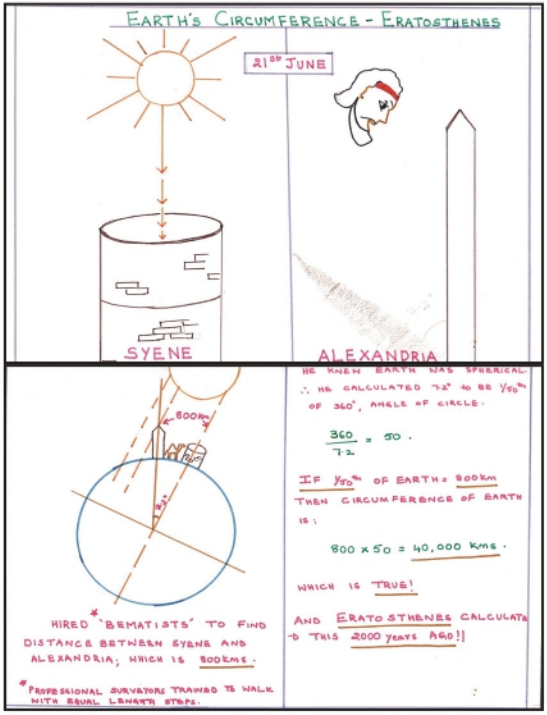
Eratosthenes calculated the circumference of the Earth using a most elegant method!

Eratosthenes

- 276-194 BCE
- Greek Polymath, Chief Librarian
- Contributed to the field of: Geography, Mathematics, Astronomy, Poetry
- Founder of Chronology (recording events based on time of occurrence)
- Father of Geography

Geography | 240 BCE

Eratosthenes - the circumference of the Earth



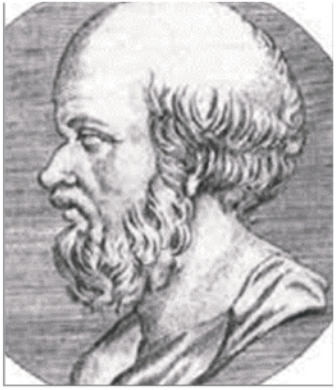
- Eratosthenes heard from travellers that at noon on 21st June every year, the sun is so directly overhead a water well in Syene, that it casts no shadow.
- Eratosthenes observed that at noon on 21st June, the sun cast a 7.2 degrees angle shadow to a pole erected in Alexandria.
- Eratosthenes knew the Earth was spherical. That is 360 degrees. 7.2 of 360 degrees is 1/50th.
- By hiring bematists (people who walk with equal paced steps), Eratosthenes calculated the distance between Alexandria and Syene to be 800 km.
- It meant that 1/50th of the Earth was 800 km. So, the whole Earth will be 800*50=40,000 km.

So?

- Eratosthenes calculated the circumference of the Earth just by measuring the angle of the Sun's shadow!
- Eratosthenes used: A pole and bematists.

Mathematics | 3 BCE

Sieve of Eratosthenes



Prime numbers are natural numbers greater than 1 and that are divisible only by 1 or by itself.

A number perfectly divisible by 2 is not a prime number. But 2 is a prime number!

The question: How can we easily identify a whole sequence of prime numbers before a particular number (ex: all prime numbers before the number 65)?

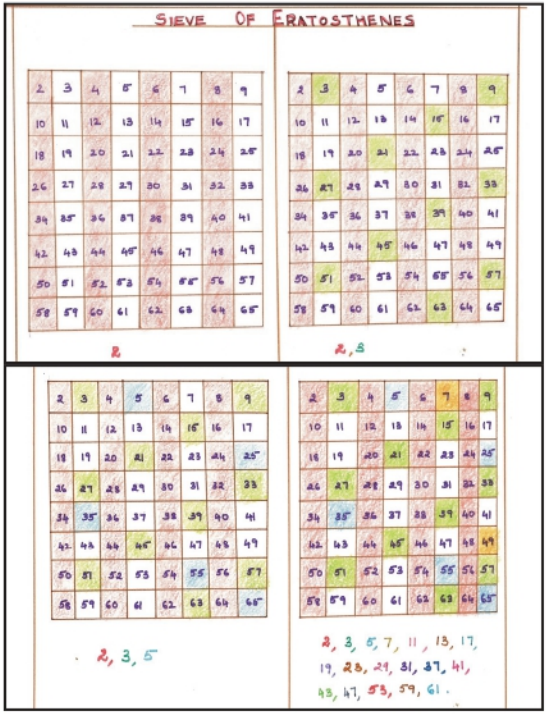
Eratosthenes provided the answer with his sieve!

Eratosthenes

- 276-194 BCE
- Greek Polymath, Chief Librarian
- Contributed to the field of: Geography, Mathematics, Astronomy, Poetry
- Founder of Chronology (recording events based on time of occurrence)
- Father of Geography

Mathematics | 3 BCE

Sieve of Eratosthenes



- Eratosthenes came up with a very simple method to find out the list of prime numbers before a particular number.
- For example, to find out the list of prime numbers between 1 and 65, the numbers have to be listed in a table as shown.
- Then, starting with 2, all the multiples of 2 have to be struck off. Then multiples of 3 have to be crossed and similarly all the multiples of 4,5,6,7,8,9 and so on have to be crossed till the multiples of all numbers are struck off.
- The remaining numbers are all prime numbers!

So?

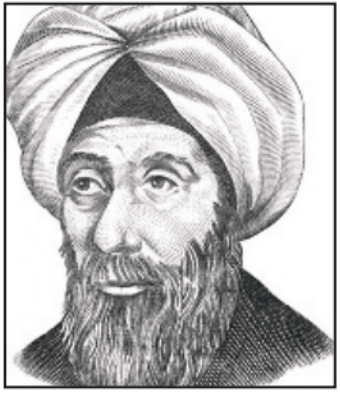
- This is a simple and ingenious way of finding out prime numbers before a given number!
- Eratosthenes used: Multiplication tables.

EXPERIMENTS FROM THE C.E
(1000 C.E onwards)

Few Firsts in Optics, Geomagnetism, Astronomy, Physiology, Microbiology, Clinical trials, Chemistry, Immunology, Palaeontology, Genetics, and Plant Biology

Optics | 1011-1021 CE

Ibn-Al-Haytham – How eyes see



The question of vision remained unsolved for centuries. Ancient thinkers believed that eyes had light of their own and that light shone out of people's eyes, like from out of a torch light.

The question: How do eyes see?

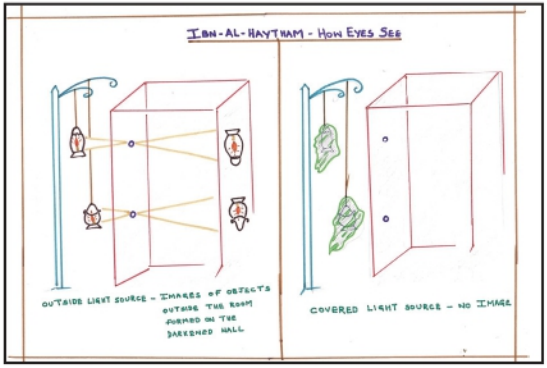
Ibn-Al-Haytham, an Arab scholar, hit upon the answer during his imprisonment!

Ibn-Al-Haytham

- 965-1039 CE
- Arab Polymath
- Contributed to the fields of Optics, Mathematics, Mechanics, Astronomy
- Father of Optics

Optics | 1011-1021 CE

Ibn-Al-Haytham – How eyes see



- Haytham darkened a room completely. He then drilled small hole in one wall. Outside the hole, he hung two lanterns at different heights.
- Light from each lantern lit up a specific region on the wall opposite, based on their height.
- The lit up regions are in straight line with the lantern. Lower the lantern, lower the region and vice-versa.
- Light disappeared when lantern was covered, and reappeared when lantern was uncovered.

So?

- Haytham proved that we see because light entering our eyes helps us see. Eyes do not have light of their own. If they had light, we should see the lighted region on the wall even when the lantern is covered. But on covering the lantern, light disappeared.
- Haytham used: Lanterns and a dark room.

Geo Magnetism | 1600 CE

William Gilbert – Earth behaves like a magnet

Even with the advent of modern technology, we cannot access the core of the Earth. Then how do we know what goes on inside the Earth and what the Earth is composed of?

The question: What is the Earth made up of? What does it contain?

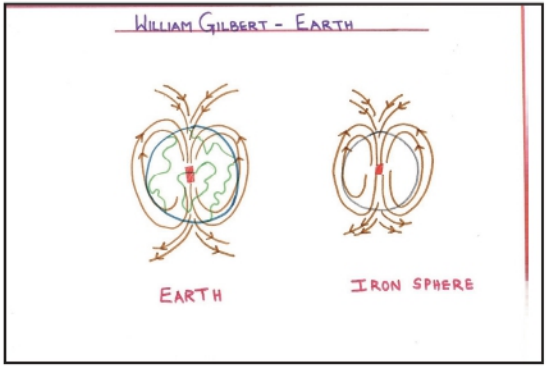
William Gilbert, an English physician, deduced the core element of the Earth.

William Gilbert

- 1544-1603
- English Physician
- Contributed to the field of Geology
- Most notable contribution: Earth's Magnetism

Geo Magnetism | 1600 CE

William Gilbert – Earth behaves like a magnet



- William Gilbert was fascinated by the compass needle deflection patterns observed on the surface of the Earth.
- He built a small sphere out of Iron oxide (magnetite/lodestone) and studied the deflection patterns of a magnetic needle placed near it.
- He noticed that the magnetic needle patterns of iron oxide sphere were similar to those of the compass needle deflection patterns seen on the Earth's surface.

So?

- Gilbert proposed that the Earth must be like the iron oxide sphere and must contain lots of iron as the deflection patterns of the Earth match that of the iron oxide sphere. Patterns match only when both objects are similar. Therefore, earth must behave like a huge magnet.
- Gilbert used: Iron sphere (lodestone sphere) and a magnetic compass.

Astronomy | 1610 CE

Galileo Galilei - Phases of Venus

Geocentric theory (that the Earth was stationary and at the center of the solar system and that the Sun and other planets revolved around the Earth) was the most widely held belief in ancient Science, to the point that supporters of Heliocentric theory (Sun is stationary and at the center of the solar system) were punished.

The Question: Is it the Sun or the Earth that is at the center of the solar system?

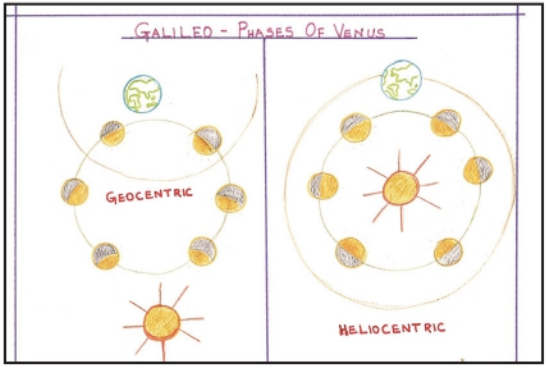
Galileo Galilei provided an answer to the question while observing the planet Venus.

Galileo Galilei

- 1564 - 1642 CE
- Italian Astronomer
- Contributed to the Fields of: Astronomy, Physics, Engineering
- Known for providing Scientific proof of Heliocentric theory

Astronomy | 1610 CE

Galileo Galilei - Phases of Venus



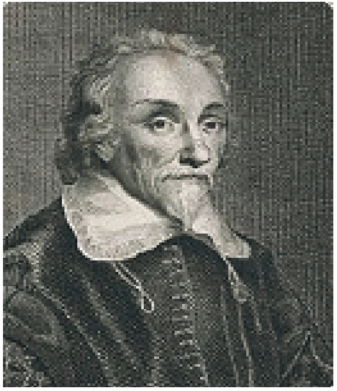
- Galileo observed that Venus showed phases of waxing and waning similar to those of the Earth's moon and had a full moon and a new moon phase.
- The 'full moon' phase of Venus occurred when Venus and the Earth were opposite to each other in their orbits, with the Sun in between. The 'New moon' phase occurred when Venus was in between the Sun and the Earth.
- Galileo proposed that these phases of Venus can be seen only if the Sun is at the center of the solar system. If the Earth is at the center of solar system, then, Venus, at all times, will appear dark and there will be no phases seen.

So?

- Galileo's observations of Venus provided proof of the Heliocentric theory of solar system.
- Galileo used: Telescope.

Physiology | 1628 CE

William Harvey - Blood circulation



Galen, physician to the gladiators, said that blood is synthesized by the liver and absorbed by the tissues. Heart is just another organ and has no specific role in pumping blood.

William Harvey was curious about circulation. William Harvey conducted experiments on various animals like fishes, reptiles, dogs, and humans to understand blood circulation.

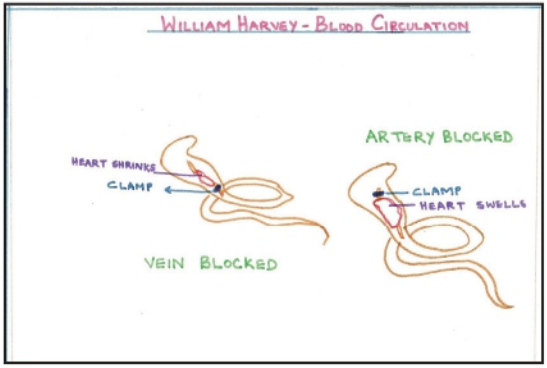
The Question: How does blood flow in the body and what has the heart to do with it?

William Harvey

- 1578-1657 CE
- English Physician
- Contributed to field of: Anatomy, Physiology
- Known for: Experiments in blood circulation

Physiology | 1628 CE

William Harvey - Blood circulation



- William Harvey tied torniquets (band) around the arms of strong, muscular farmers. He then inserted a probe into their veins and tried to push it away from heart. The probe always moved towards the heart, proving veins carry blood to the heart.
- Using animal models, he saw that the heart had very little blood when veins were blocked. Whereas when he clamped the artery, he saw that the heart expanded with blood.
- He noticed that the heart has two beats - one when blood in the heart empties into arteries, another when blood flows into the heart from veins.

So?

- He concluded that veins carry blood to the heart and that arteries carry blood away from the heart. Heart is essential in controlling blood circulation.
- Harvey used: Animal models and Human volunteers.

Optics | 1672 CE

Sir Isaac Newton – Property of light

During the Newton Era, it was argued that light is pure white. The rainbow colours become visible when impurities are added to light by passing it through objects like glass.

The question : Are colours an inherent property of white light or are they impurities added to light?

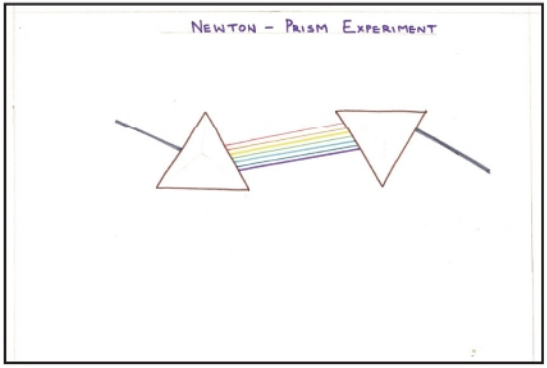
Sir Isaac Newton solved the question once and for all in a dark room.

Sir Isaac Newton

- 1643-1727 CE
- English Physicist, Mathematician, Astronomer
- Contributed to the fields of: Physics, Mathematics (Calculus)
- Most famous for : Laws of Motion, Gravity

Optics | 1672 CE

Sir Isaac Newton – Property of light



- Newton incident sunlight passing through a small slit on the door of a darkened room onto a glass prism. The white light split into the seven colours of the rainbow upon passing through the prism.
- Newton then incident these rainbow colours on to a second prism placed at a little distance from the first. The rainbow colours blended, and out of the second prism came white light again!

So?

- Newton proved that colour is a property of white light and is not an impurity added to it when it passes through objects like glass. If colour is an impurity, then more colour should be added when it passes through the second prism! He gave the artists the colour chart!
- Newton used: Glass Prisms.

Origin of Life | 1668 CE

Francesco Redi - Life arises out of pre-existing life

It was believed that all life, including mice, arose from mud and rotting garbage. It was called 'spontaneous generation.'

The question : Did life arise from pre-existing life or did it arise spontaneously?

Francesco Redi's elegant experiment provided the much needed proof.

Francesco Redi

- 1626-1697 CE
- Italian Physician
- Contributed to: Biology, Parasitology, Toxicology, Natural Science, Philosophy
- Father of Modern Parasitology

Origin of Life | 1668 CE

Francesco Redi - Life arises out of pre-existing life

- Francesco Redi took two clean jars in which he put rotting pieces of meat. He covered the mouth of one jar with a cloth and left the mouth of the other jar open.
- Flies feasted on the rotting meat in the open jar, but could not enter the covered jar.
- Few days later, maggots were seen on the meat in the open mouthed jar, while the meat in the covered jar was clean.

So?

- In open jars, flies visit, lay eggs and give rise to maggots. In closed jars, flies cannot enter and hence, no maggots! This proved that life comes out of pre-existing life and not spontaneously out of mud or garbage!
- Francesco Redi used: Clean glass Jars and rotting pieces of meat!

Clinical Trials | 1747 CE

James Lind – Cure for Scurvy

Scurvy was considered a deadly disease till James Lind came along. Scurvy causes exhaustion, bleeding gums and teeth, pain in bones and legs, spontaneous bleeding, anaemia and depression. Many sailors died of it. But then, nobody had a proven method/medicine to cure it. They just did not conduct a clinical trial.

The question : How can we know whether a particular cure works for a disease or not?

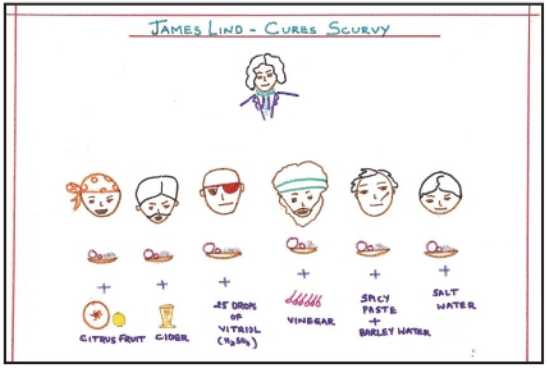
James Lind gave the world the concept of clinical trials with his experiment.

James Lind

- 1716-1794
- Scottish Physician
- Physician of the Royal Navy
- First person to conduct clinical trials

Clinical Trials | 1747 CE

James Lind – Cure for Scurvy



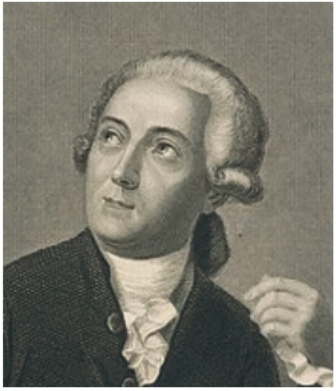
- When 12 sailors got affected with scurvy on his ship, Chief physician James Lind thought that acids might help cure scurvy.
- He separated the 12 sailors into 6 groups of 2 each. He gave all of them the same basic meal with just one difference- the acids. To the first group he gave cider, to the second group he gave 6 spoons of vinegar, to the third - salt water, to the fourth - 25 drops of vitriol, to the fifth - a spicy paste and barley water, and to the last - citrus fruits like oranges and lemons.
- The group that received citrus fruits quickly recovered from scurvy and went back to work.

So?

- James Lind proved that citric acid in citrus fruits cures scurvy!
- James Lind used: Food!

Chemistry | 1789 CE

Lavoisier – law of conservation of mass



It was believed that every substance that burns has a fire catching element within it called 'Phlogiston'. Substances burn till phlogiston is released into the air. And after burning, the substance loses weight, because it loses phlogiston. But air cannot catch fire because the phlogiston in air is absorbed by trees.

The question : What makes a substance burn?

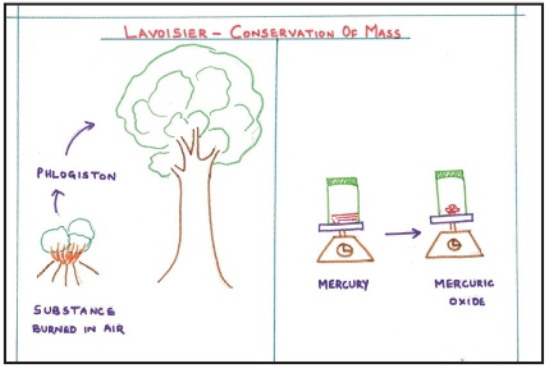
Lavoisier did not believe in phlogiston. His experiment helped discover what helps substances burn.

Antoine Lavoisier

- 1743-1794
- French Chemist
- Contributed to the fields of: Chemistry, Biology
- Proposed the 'Law of Conservation of Mass'

Chemistry | 1789 CE

Lavoisier – law of conservation of mass



- Lavoisier weighed mercury placed in a sealed jar. He then burned the mercury till he got the red calx, or mercuric oxide. He weighed the jar again. The jar weighed nearly the same - a bit more than before.
- Lavoisier concluded there is no loss or gain of mass in a reaction. And no phlogiston either. Substances burn when combined with air. Air has two components – one that is breathable, supports burning, and which can combine with metals to form calces; oth-er- which is not breathable and cannot support burning.

So?

- He proved that in a chemical reaction, the weight of the reactants is equal to the weight of products, i.e., chemical reactions are balanced.
- Lavoisier used: Sealed metal jar, mercury, weighing balance.

Immunology | 1796 CE

Edward Jenner- Vaccination for smallpox

It was common knowledge that people once infected with smallpox or with the milder cowpox were resistant to a second infection with smallpox. Benjamin Jesty, a farmer, infected his family with cowpox to protect them from smallpox infection.

The question : How can one be certain that a prior infection of smallpox or a milder infection with cowpox protects that person from a reinfection of smallpox for life?

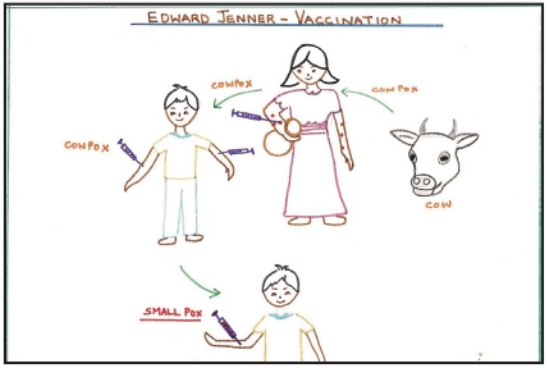
Edward Jenner's experiment proved it beyond a doubt!

Edward Jenner

- 1749-1823 CE
- British Physician, Scientist
- Contributed to the field of: Zoology, Medicine, Immunology
- First Vaccine for smallpox

Immunology | 1796 CE

Edward Jenner- Vaccination for smallpox



- Edward Jenner observed that milkmaids who got infected with cowpox, a disease affecting cows, were resistant to infection by smallpox, a deadly disease.
- He thought that prior infection with cowpox somehow made them resistant to smallpox.
- He injected pus taken from the cowpox boils on milkmaid Sarah Nelmes's hands, into both arms of 8-year old James Phipps.
- James developed fever, but recovered quickly.
- After a few days, Jenner infected James with smallpox virus. James did not develop the disease. James was resistant to smallpox.

So?

- Jenner proved that infection with less dangerous cowpox protected people against the deadly smallpox. This was the first successful vaccination trial ever.
- Jenner used: Pus from cowpox boils and pus from smallpox boils.

Paleontology (Coprolites) | 1820 CE

Mary Anning – Diet of ancient reptiles

Archaeologist and paleontologist dig up the Earth in an attempt to understand past life on the Earth. They use anything from bones to bone china to further their knowledge.

The question: How can excreted material help in our understanding of extinct creatures?

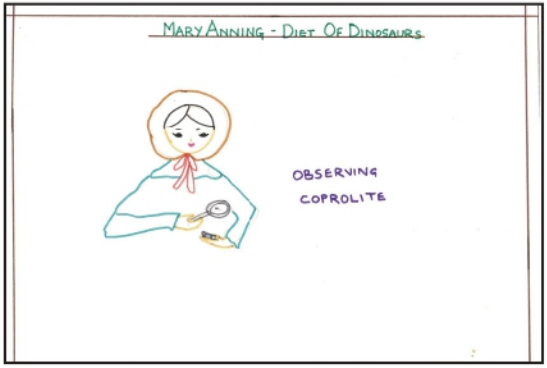
Mary Anning gave us the insight.

Mary Anning

- 1799-1847 CE
- English Paleontologist, Dinosaur fossil hunter
- Contributed to the field of: Paleontology, Dinosaur facts
- First to suggest that bezoar stones are fossilised poop or coprolites of ichthyosaur
- Dug up the full fossil of Ichthyosaur at the age of 12

Paleontology (Coprolites) | 1820 CE

Mary Anning – Diet of ancient reptiles



- Mary Anning was the first to identify that bezoar stones were fossilised faeces of ichthyosaur or plesiosaur.
- She observed the bezoar stones/faeces carefully and saw fish scales and fish bones in them. This led her to propose that ichthyosaur could be a fish eater.
- She was the first to use fossilised faecal samples, now known as coprolites, to identify the diet of pre-historic creatures.

So?

- If the faecal sample has bones and teeth of other animals, it is a meat eater. If the sample shows tree bark or plant remains, it is a herbivore. Looking through faecal samples provides important clues to the diets of extinct animals. It is also used today to study big cats.
- Anning Used: Fossilised Faecal samples or coprolites.

Geology | 1846 CE

Robert Bunsen-how hot spring geysers work

The quest to understand natural phenomena has always dominated human existence, be it volcanoes, earthquakes, tornadoes or something much simpler as hot spring geysers.

The question : How do hot spring geysers work?

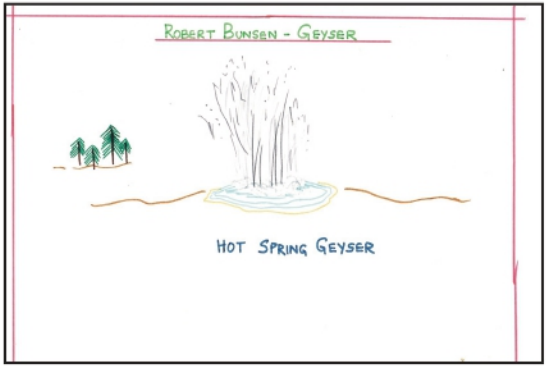
Robert Bunsen daringly entered a geyser to provide us the answer.

Robert Bunsen

- 1811-1899
- German Chemist
- Contributed to the Field of: Photochemistry, Spectroscopy, Gas-analysis and Geology
- Most noted for: Spectroscope

Geology | 1846 CE

Robert Bunsen-how hot spring geysers work



- Robert Bunsen climbed down the shaft of a hot spring geyser and measured the temperature.
- Though the temperature was much higher than the boiling point of water, he noticed that the water was still liquid and has not turned into steam due to the pressure at the bottom of the vent.
- But because the water at the very bottom is always in contact with hot rock, the temperature of water keeps rising, and then, in spite of all the pressure, spouts out of the vents onto earth.
- And the water spouts out of geysers at regular intervals.

So?

- By descending into the geyser and inserting a thermometer at the bottom of the geyser, Robert Bunsen discovered how geysers work.
- Robert Bunsen used: Thermometer.

Microbiology | 1859 CE

Louis Pasteur- Germ theory

Ancient civilizations considered diseases to be punishments sent down. The cause of the spoilage of food, beverages, and diseases was not known for long. And then, along came Francesco Redi who proved that life comes out of pre-existing life. This led to the idea that spoilage of food, beverages, and the cause of diseases could be due to miniscule live particles in dust.

The question : How do beverages and food get spoilt? How do infections arise?

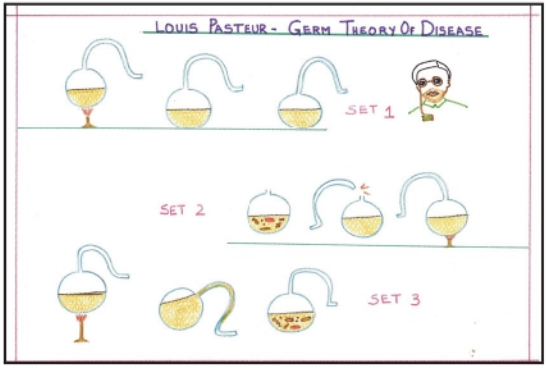
Pasteur broke a few swan neck flasks to find a solution.

Louis Pasteur

- 1822-1895 CE
- French Chemist and Microbiologist
- Contributed to the field of: Microbiology and Immunology
- Known for: Germ theory, Vaccines and Pasteurization

Microbiology | 1859 CE

Louis Pasteur- Germ theory



- Pasteur put liquid that supports microbial growth in a swan necked flask. He heated it to kill microorganisms. The long swan neck trapped dust particles from air. No dust entered the liquid. Liquid remained unspoilt.
- He took fresh liquid in another swan necked flask, heated it, and then broke off the swan neck. Dust particles from air entered the liquid. Liquid got spoiled.
- He took fresh liquid in another swan necked flask, heated it. He then tilted the flask till the liquid entered the swan neck. The dust particles trapped in the neck contaminated the liquid. Liquid got spoiled.

So?

- Pasteur proved that germs present in the air spoil liquids and other foods and cause diseases.
- Pasteur used: Swan necked flasks and nutrient liquid.

Genetics | 1856-65 CE

Mendel - Garden peas

It was believed that traits of parents blended/mixed in the progeny. If the favourable trait in one parent is blended with the not so favourable trait in the other parent, then the progeny will have less of the favourable trait. After a few generations, favourable trait would be completely lost. But that is not how natural selection, as proposed by Darwin, works.

The question : Do parental traits blend/mix in the offsprings? How are traits inherited?

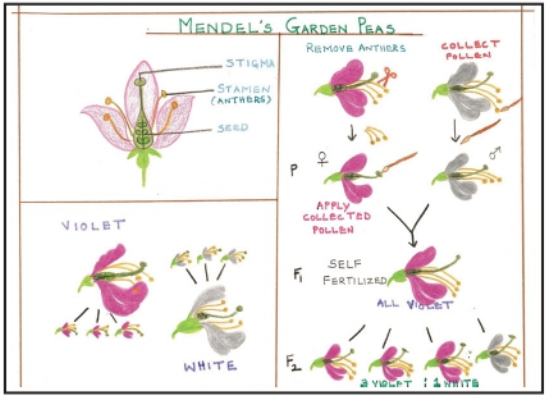
Gregor Mendel found the solution while working on garden Peas.

Gregor Johann Mendel

- 1822-1884
- Austrian Monk
- Contributed to the fields of : Biology, Mathematics, Meteoreology
- Father of Genetics

Genetics | 1856-65 CE

Mendel - Garden peas



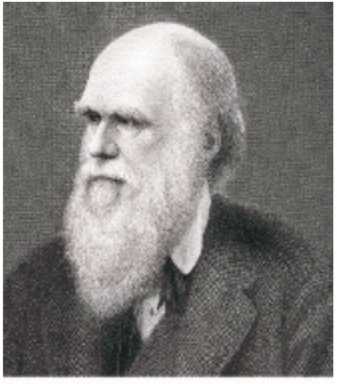
- Mendel crossed a purple flowered plant with a white flowered plant. All the next generation plants (F1) were purple, like one parent. If traits blended, F1 would have had light purple flowers.
- Mendel then crossed two F1 purple plants. F2 showed purple flower: white flower in 3:1 ratio. If traits had blended, white flower cannot arise out of F1 purple plants.

So?

- Mendel proposed that every trait exist in two forms - dominant and recessive. Ex: Tall-Short, Purple-White.
- The trait seen in every generation - parent, F1 and F2, is Dominant (purple flower). The trait seen in some generations – Parent and F2, is recessive (white flower). Dominant trait masks recessive, making it seem to disappear. Recessive reappears because there is no blending.
- Mendel used: Garden pea plants and mathematics.

Plant Biology | 1880 CE

Charles Darwin – Phototropism



Plants grow towards light. But is it that the entire plant bends towards light, or is it some specific part of the plant that shows phototropism (bending towards the source of light).

The question : Which part of the plant grows towards light?

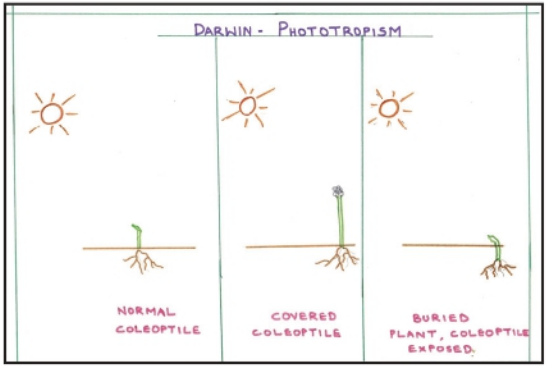
Darwin and his son Francis had a similar doubt, and they conducted an experiment to clarify it.

Charles Darwin

- 1809-1882 CE
- English Naturalist
- Contributed to the fields of : Evolution, Biology, Geology
- Best known for : Origin of Species

Plant Biology | 1880 CE

Charles Darwin – Phototropism



- To identify which part of the plant showed phototropism (growth stimulation towards light), Charles Darwin and his son Francis used germinated grass seeds. The coleoptile (the part covering the first shoot) sprouted first.
- Darwin covered only coleoptile tip with metal foil. The rest of the coleoptile was exposed to light. Covering the coleoptile prevented the plant from bending towards light source. It just grew straight.
- Next, they buried the whole plant in soil, but exposed only the tip of coleoptile to light. The plant showed bending towards light.

So?

- Darwin and Francis proved that it is the tip of the coleoptile that shows phototropism and not the rest of the plant.
- Darwin and Francis used: Grass seeds, light source.

Optics | 1928 CE

Sir C V Raman – Raman effect

At one time it was thought that blue of the sea is a reflection of the blue of sky in water. But no one studied it till the 1900s.

The question : Where does water get its colour from? Or for that matter, at dawn or dusk, where does the red in the sky come from?

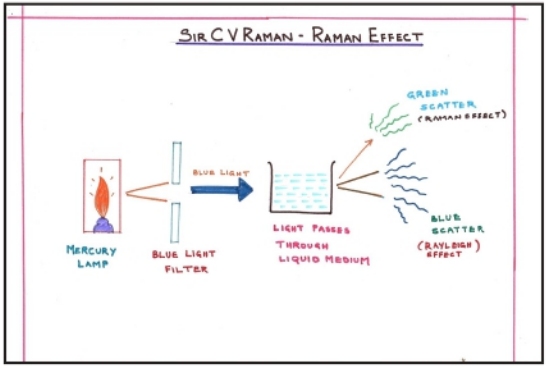
Sir C.V. Raman studied it all.

Sir C V Raman

- 1888 – 1970
- Indian Physicist
- Contributed to the Field of Physics
- Best Known For : Raman Effect
- First Asian to receive a Nobel Prize

Optics | 1928 CE

Sir C V Raman – Raman effect



- Using mercury lamps and coloured light filters that allow only a specific colour light, like blue or green, to pass through, Sir Raman studied light scatter/reflection of liquids.
- He found that specific coloured light entering a liquid is reflected/ scattered largely in the original colour; and a small amount in different colour. This small scatter of differently coloured light by liquid molecules is called 'Raman Effect.'
- He noted that water molecules scatter or reflect more blue light from the light entering water, than any other colour of the visible spectrum, making the sea appear blue. But the small scatter of green gives the sea an opalescence.

So?

- He proved that the glow of sea and red sky at dawn is due to Raman effect.
- He Used: Mercury lamp, liquids like water and Glycerine, light filters.

References

https://www.popscicles.com/books

Author Bio

Her work can be viewed at:

https://www.popscicles.com

https://youtube.com/rohinichintha

Rohini Chintha is passionate about everything Life and Science. She experiments on methods to communicate Science both in the classroom and on various storytelling platforms like popular Children's magazines of the country, Hyderabad Literary Festival (HLF) and British Council, Hyderabad. She dons the caps of a Science teacher, Science communicator, children's writer, storyteller and You-tuber.

She specializes in narrating 'Science stories' to audiences of all ages. She deeply enjoys writing for children and believes a 'Happy Childhood contributes to a Happy Society'.

She received awards for her doctoral work, storytelling, writing and for communicating Science using stories.

She currently teaches Biotechnology at the Department of Genetics and Biotechnology, VCI Women's University (formerly University college for women, Koti), Hyderabad. She founded Pop-Sci-Cles (popular Science and common tales) in 2019 to popularize Science. She is a freelance translator into telugu and has worked with Nature communications foundation (NCF) and NBT, Delhi.

She spends her spare time reading books, watching movies and thinking about ways of communicating Science.

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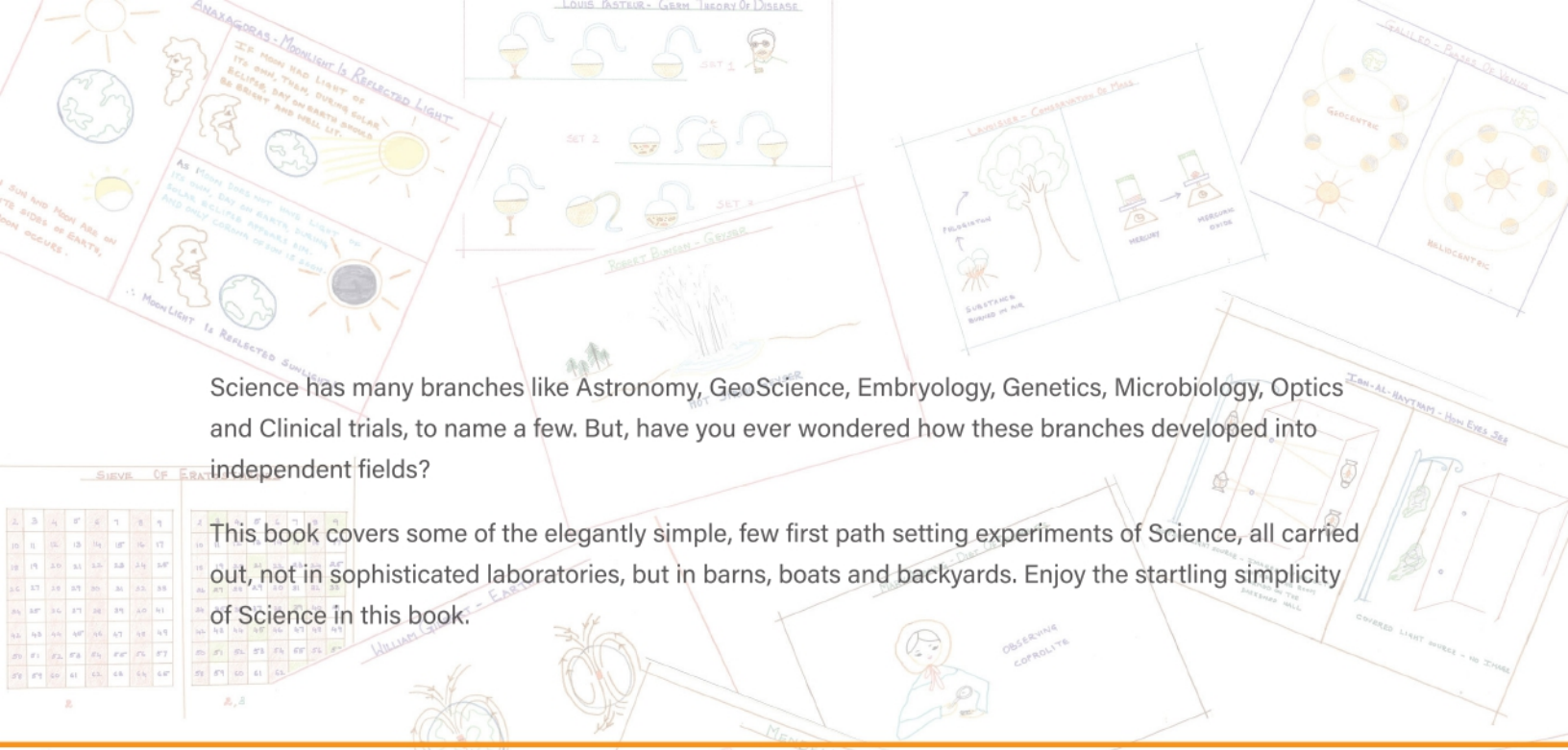

Science has many branches like Astronomy, GeoScience, Embryology, Genetics, Microbiology, Optics and Clinical trials, to name a few. But, have you ever wondered how these branches developed into independent fields?

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