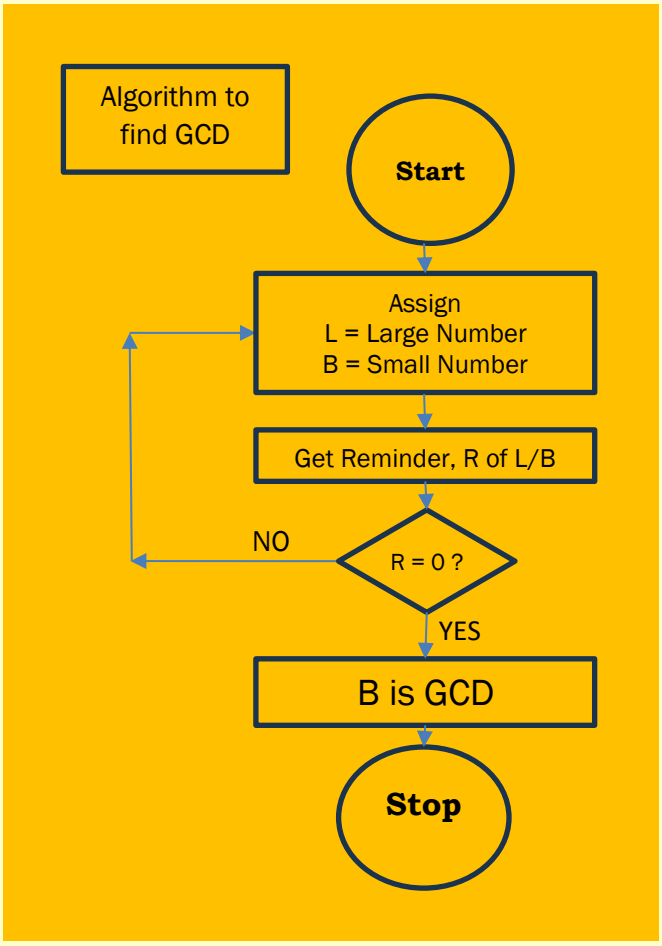
Navi Mumbai Science Foundation
EdUREKA
Education for Spirit of Science

Volume 5, Issue: No. 2 **April – June 2024**

HOW do we do maths?



Navi Mumbai Science Foundation
[Regn. No.: Maha/2592/10/ (Thane)
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April-June 2024

Volume 5, Issue: No. 2

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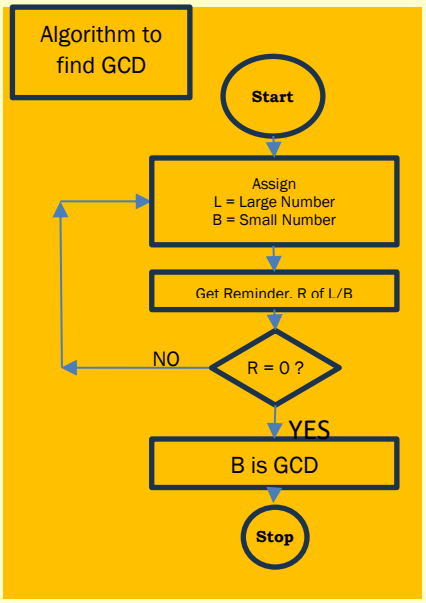


This is a quarterly e-magazine published by Navi Mumbai Science Foundation, a society engaged in spreading science education and scientific temperament among students of Navi Mumbai region for the last one decade. The magazine will mainly cover activities and articles on science education useful to students, teachers & society at large.

Views expressed in the magazine are from authors and editor may not agree with it.

To receive the copy of E-magazine, send your mail id to edureka.nmsf@gmail.com

From Editor's Desk!!....

Editor's Corner

Dear Students and Teachers, due to unavoidable circumstances there was a delay in publication of issues, but we are now back with issues of interest for you. We are also introducing articles which are essays written by students.

These essays are published verbatim, i.e. as submitted by students, since based on what they had submitted, they have won awards decided by a jury of experts which is independent of the editorial board of this magazine. None of these essays is edited by the editorial board. Hence, the reader should independently verify the content of the articles for its correctness, and also the English language.

We are also introducing a very interesting series on activities which can be done by students with a paper, pen and a calculator. It deals with the solar system.

We are now planning some more activities which will feature in future issues.

P. K Joshi

Activity Based Learning

A step towards developing Mathematics Laboratory

For those who play mathematics (up to class x)

Unit 1: All about a Rectangular Piece of paper & Its Application in Finding Factors and LCM and GCD.

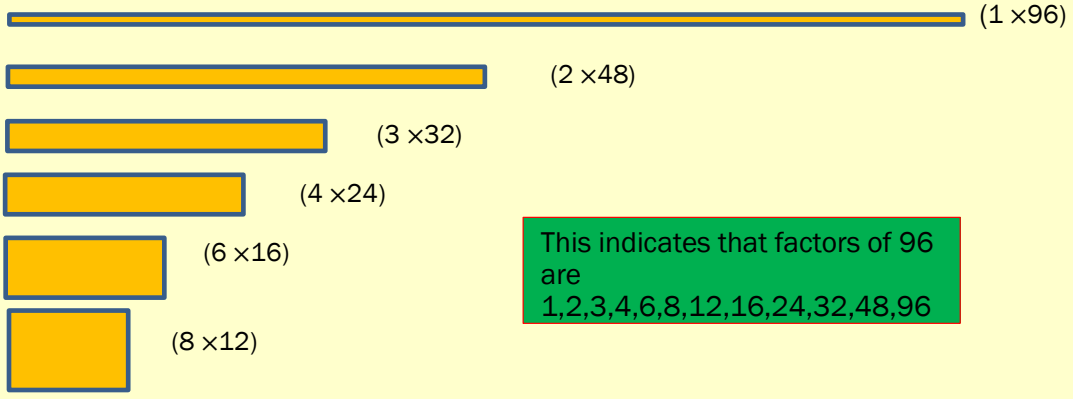
i. Finding factors

See this is a rectangular piece of paper.
Measure its length (L) and breadth (B).
We have say, its length is 12 cm, breadth is 8 cm and what more its area is $12 \times 8 = 96\ cm^2$
But I view the length and breadth (12,8) as factors of the area 96.

Thus, area of rectangle represents the number and its length and breadth represent the factors of that number.

Now think, how many such rectangles can be constructed. Try.

Activity: Cut rectangular pieces of area 96 cm^2 of integral length and breadth. We have the six rectangles.

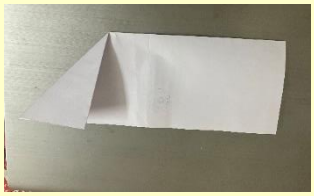


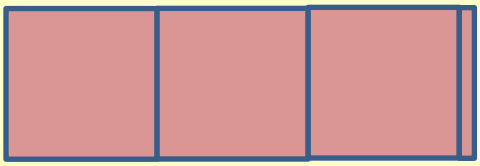
This indicates that factors of 96 are 1,2,3,4,6,8,12,16,24,32,48,96

Thus, we can get factors of an integers.

ii. Can we use this criterion to find divisibility?

For example, find whether 8 divides 25



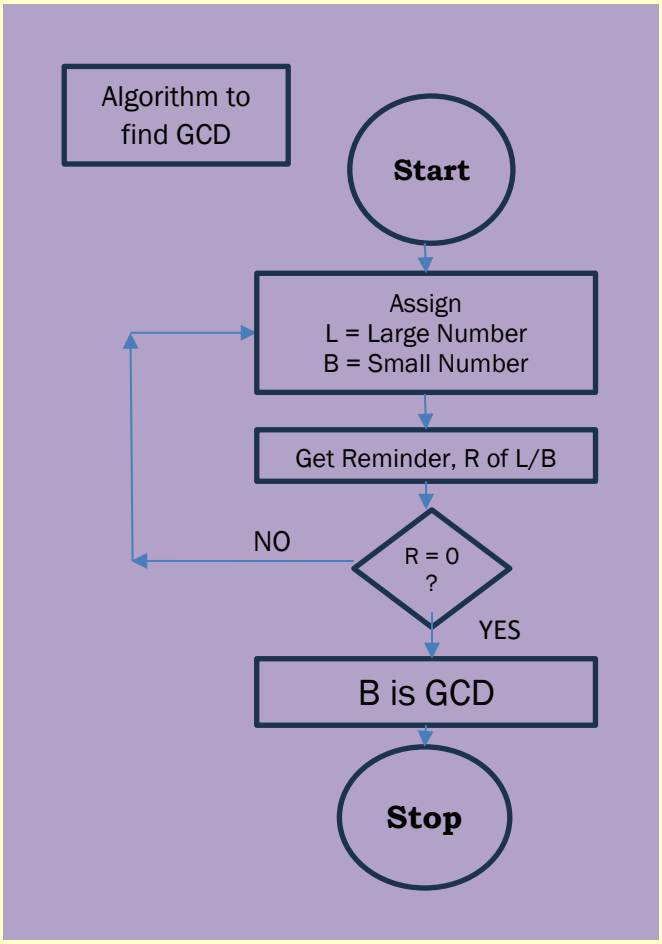


Take a rectangle of size 8× 25
By folding over angle bisector of any corner take off biggest squares from it. (See the fig). Continue this till we are left with a strip of width less than 8.
We are left with (1× 8).

⇒ 8 does not divide 25

iii. Let us extend this criterion to GCD

We know that, the product of any two integers is the product LCM × GCD of those numbers.
⇒ Area of rectangle = L×B = the product of two numbers
Here we can assign,
L = Length of rectangle = Greater number
B = breadth of rectangle = Smaller number.
We know according to Euclid method,
(L – n × B) = 0 then B is GCD of L and B.



Find GCD of 24 and 9

Study the following methods and think how can we achieve this by folding a rectangle.

The Euclid's algorithm

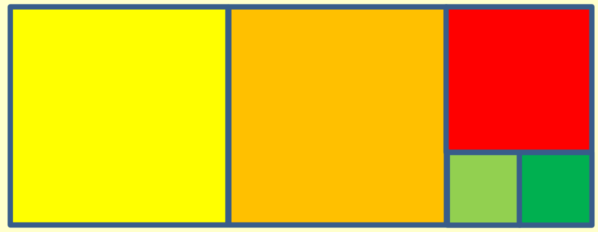
G.C.D. (24, 9) =GCD {(24 – 2× 9), 9}
=GCD (6, 9)
= GCD {(9 – 6), 6}
= GCD (3, 6)
=GCD {(6-3), 3}
= GCD (3, 3)
G.C.D. = 3

```
The long division method
9) 24 (2
    -18
-----------
      6) 9 (1
         -6
      ------------
           3) 6 (2
              -6
              -------
               0
G.C.D. = 3
```

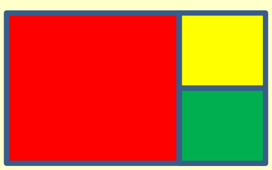
Length -breadth	Remaining
24 – 9	15
15 – 9	6
9 – 6	3
3 – 3	0
GCD = 3	

These steps can be achieved by rectangular piece of paper. See how

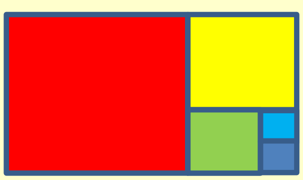
Rectangle – biggest square	Remaining rectangle
24 x 9 – 9 x 9	15 x 9
15 x 9 - 9 x 9	6 x 9
6 x 9 - 6 x 6	3 x 6
3 x 6 - 3 x 3	3 x 3
3 x 3 - 3x 3	0
Length of side of last square =GCD = 3	



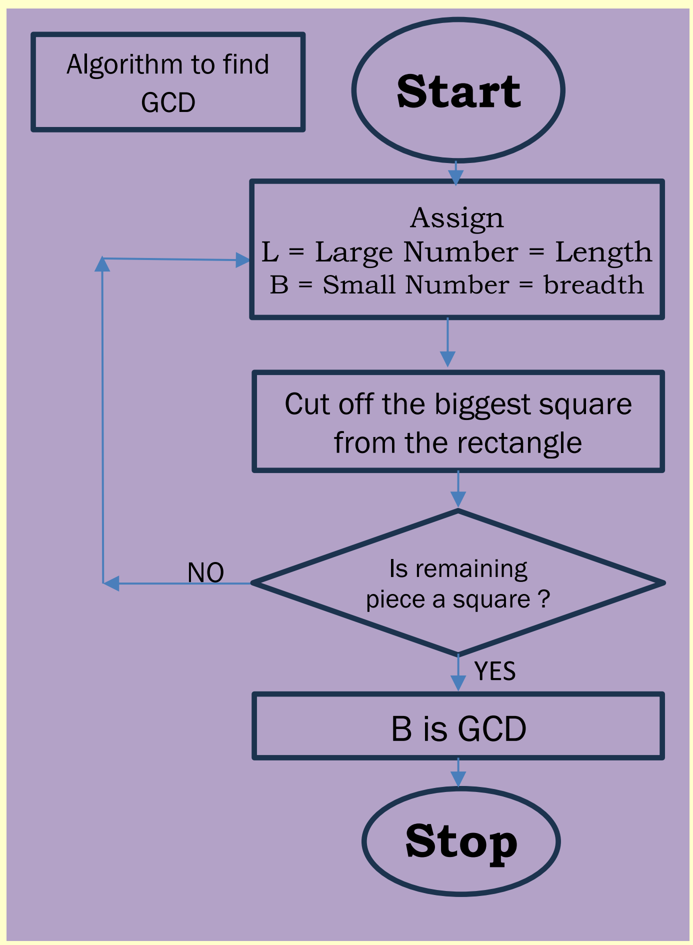
Side of last square obtained is GCD



GCD of 12 and 8 is 4



GCD of 5and 8 is 1

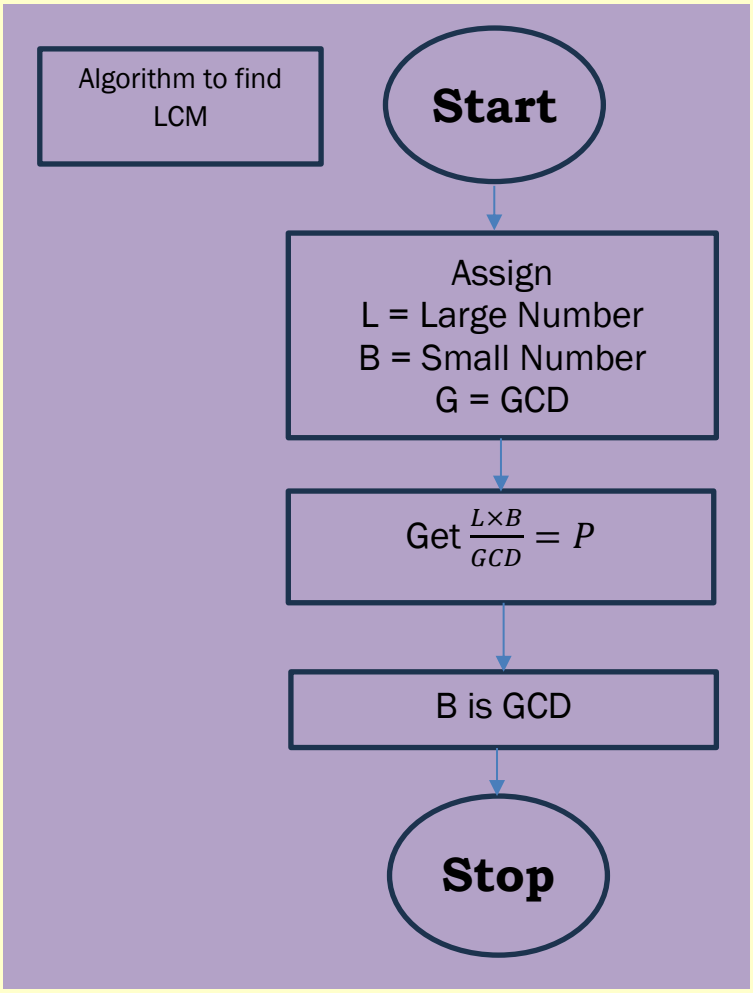


iv. Now think about LCM.

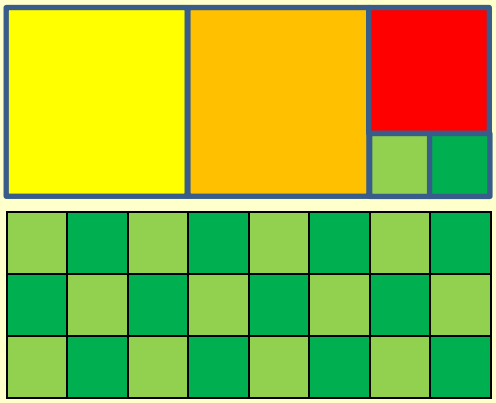
Steps:

- First find GCD
- Then find $\frac{L \times B}{GCD}$ to get LCM

  Then think how to achieve this division using papers.
  Here big rectangle is L×B and
  Area of last square = $(GCD)^2$
  Find how many squares can occupy the whole space.
  (n)
  Then n× gcd = l cm



Find LCM of 24 and 9

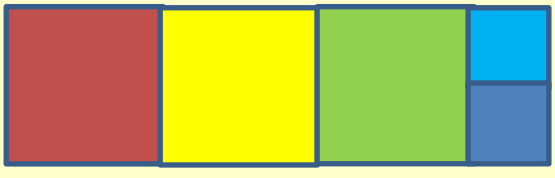


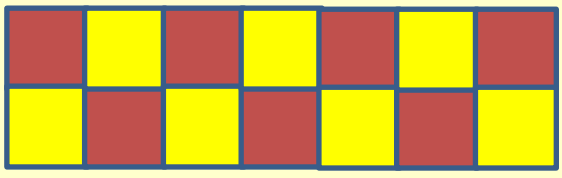
Number of small squares = n = 24, then LCM = n× gcd = 24× 3 = 72

Find LCM and GCD of 42 and 12

Ans:

GCD = 6 and LCM= 14× 6 = 84





Suresh Borgaonkar
Retired Science Maths Teacher
Pandit Bachhraj Vyas Vidyalaya

Are we consuming more energy than we are supposed to?

In the year 2022, world consumed 580 million Tera Joules of energy which is equal to about 14,000 (13868 as per another estimate) Mtoe, as per the statistics available from the site. https://yearbook.enerdata.net/total-energy/world-consumption-statistics.html.

The unit 1 M tonne-equivalent-oil (1toe) = 11.63 TWh (1.163×10^{13} Wh).

At the same time India consumed 951 million toe which is around 7% of total consumption of energy (not just electricity).

1 M toe = 41868×10^{12} J of energy

Which means that world consumed 2.0×10^{20} J of energy in last year. This is equivalent to (dividing by 365, 24 and 3600) 6.5×10^{12} J every second.

As per current capacity, to generate electricity from solar panel, 20,000 m^2 of solar panel generates 1 MJ every second. The surface area of earth is 5.1×10^8 km^2 which is equal to 5.1×10^{14} m^2.

This equals to 2.5×10^{10} units of 20,000 m^2 area which means 2.5×10^{10} MJ/s = 2.5×10^{16} J/s, which can be generated at the maximum, in comparison to 6.5×10^{12} J consumed every second.

If we can use only the land mass (all of it) we can generate only 29% i.e. 7.2×10^{15} J/s. But that would mean complete destruction of forest etc. and the ecosystem of planet earth. So, if we can use 1% of earth's surface area, we can at the best generate only 2.5×10^{14} J every second, as compared to consumption of 6.5×10^{12} J every second. Which amounts to 2.6 %.

So even though total consumption is much less compared to what we receive on earth, is it possible to tap that energy? As of today, the total world (installed) capacity is 1000 GWh which is equivalent to 1×10^{12} J every second.

Which is only about 15% of world's consumption. So where is the rest 85% coming from?

Well, it is like the scenario described below.

Your monthly expenditure is 6500 rupees but you are earning only 1000 rupees a month. Rest of it comes from the bank balance, that your ancestors have left for you. But that amount is limited. I can increase my salary to 250,000 per month at the maximum, but it is not so easy.

In terms of energy, it is the fossil fuels, which have accumulated over few million years. There is energy from nuclear sources, which is independent of solar energy but that is not used much.

In India, as per the Government statistics, the energy production is as given in table below. Column two gives the installed capacity in GWh.

Fuel	GWh
Coal	212
Gas	25
Diesel	0.6
Nuclear	7
Hydro	47
Wind	43
Solar	67
Bio mass	10
Waste	0.5
Small Hydro	5

Which totals around 416 GWh capacity. As you can see that Solar + Wind amounts to around 26%, but world average is only about 13%.

This shows that huge amount of consumption of fossil fuels (or the bank balance left by our ancestors). The fuel which was accumulated over a few million years, we are happily blowing it away.

In the history of world which is at least a billion years old, the fossil fuel which got accumulated over many million years, will be used up by humans in few hundred years. Is this appropriate?

The solution is less consumerism, which means to consume less, only what we need to live comfortably. The journey begins at home. Do we waste energy? We will see in the next issue, how we consume energy where it is not required. Consumption of food, temperature of our car, home etc.

Dr. P K Joshi
Homi Bhabha Centre for Science Education (TIFR),
Mumbai

Nobel Laureatism Essay competition 2023-24

II Prize winning Essays

Saee Shinde

Podar International School ICSE, Nerul.

Biology II Prize

Svante Pääbo, the narrator of the story of our evolution

Earth, the most unique planet in the solar system. Its uniqueness lies within the fact that it is the only planet that we know of that supports life, so diverse, ranging from unicellular organism to highly complex ones like us, humans, humans are the most developed life on the planet, yet, after achieving such high order of thinking, we are still questioning our very own origin. Where do we come from? How are we related to each other, and those who came before us?

Dr. Svante Pääbo Has achieved a major breakthrough in answering these questions. He did this by sequencing the genomes of Neanderthals, our now extinct, and closely related and ancestors. His work was acknowledged by the Royal Swedish Academy of sciences and awarded him the noble prize in physiology or medicine in the year 2022 for his pioneer Ring work in Paleogenetics.

Genome is the entire collection of genetic material that makes up an individual. All genetic material is stored in the form of the Deoxyribonucleic acid (DNA) in the nuclei of our cells. DNA is made of four nitrogenous basis, Adenine, Thymine, Guanine and Cytosine that come in and their arrangement determines the genetic code. This process of determination of arrangement of the basis is called sequencing.

Svante Pääbo Was born on 20 April 1955, in Stockholm, Sweden to Noble laureates. He is educated in Egyptology and medicine and has earned his doctorate in immunology and his post doctorate in molecular biology and biochemistry. Some of his notable works include a research project on the effect of E19, a protein produced by infectious adenovirus on the immune system. With his passion in genetics, he proved that New Zealand's Maos, which are now extinct, are closely related to Australia's emus than they are to Kiwis. His most recent and remarkable contribution in the field of anthropology is the discovery of another close relatives of ours, the Denisovans dubbed after the Denisova cave in Siberia. This entirely new branch of humanity was uncovered when high-quality genome was extracted from a little finger bone.

He commenced his studies in an genetics by extracting and sequencing DNA from ancient Egyptian mummies, but while doing so, it was noted that the DNA sequence probably belonged to a museum, curator or archaeologist as the DNA was long, which was unlikely as DNA disintegrates over time. To avoid this problem, his team worked in clean room conditions in rooms where the concentration of airborne particles can be controlled. They developed ways to increase the yield of Neanderthal DNA and computer programs that used human genome and that of chimpanzees to acquire a complete Neanderthal genome.

How does this genetic contribution affect us? In 2020 while looking for a risk factors of contracting the Covid 19 virus, a very strong risk factor manifested itself on chromosome 3, which was very similar to the Neanderthal genome.

On the same chromosome about half 1 million base pairs away, the CCR5 variant is present, which is the co-receptor of HIV. This coreceptor is present in less numbers in the Neanderthal variant. To control, the Neanderthal variant is like a double-edged sword which increases susceptibility of COVID-19 virus while decreasing the risk of transmission of HIV by 27% in those who possess it.

It also increases blood coagulation, which might have been of great help to Neanderthal. It is also linked to many psychological and Neurodivergent effects like increasing or decreasing risk to depression.

The most wholesome use of genome sequencing is that we can now reconstruct Neanderthal family trees. In Chagyskaya Cave, in Russia, about 60 Neanderthals were found out of which, a father daughter pair was identified. This is by for my favourite application of genetics in this field as it gives the blurred specs that are lost in time a face. Has an archaeology enthusiast. I find it fascinating. How remains bones and fragments peace by peace? Rebuild the life of those people and remind us that they lived. They were alive struggled through this challenging world, left us a legacy that mould us to who we are today. Truly humanizing to look into their lives and finding similarities between us, though a huge time gap.

They use the 454 sequencing method wherein the extracted DNA was broken down into small fragments, called adapter. These adapters were then allowed to bind to tiny resin, beads where they are multiplied numerous times by polymerase chain reaction.

The beads are filtered and placed in wells on sequencing plates along with enzymatic beads containing DNA polymerase, and primer required for the sequencing reaction. Nucleotide bases are added one by one to the wells, first Adenine, Cytosine, Guanine and Thymine. Light is allowed to fall on the mixture, the intensity of light corresponding to the number of same nucleotides, and by plotting these intensities of light, the DNA sequence can be decoded.

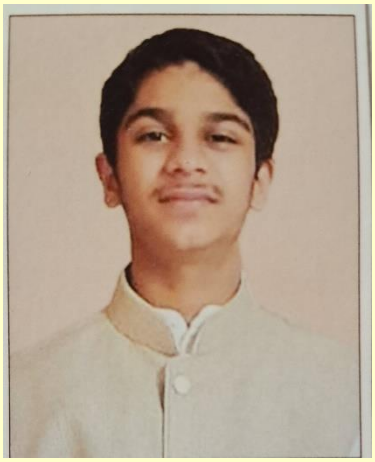
On sixth of May, 2010 at the Max Planck Institute of evolutionary Anthro ology, Svante Pääbo and his team, sequenced the entire mitochondrial DNA of a 38,000 year old female Neanderthal found in the Vindiya Cave in Croatia, for the very first time. He proved that Homo sapiens and homo Neanderthalensis are two genetically different species who produced a common of spring during their meeting 50,000 years ago.

For the very first time, we had the genetic insight of an extinct branch of humanity, and we will go on to discover that they are not extinct as such as a part of their DNA still lingers within us. About 2 to 4% Neanderthal DNA is present in the gene pool of non-African descents. We go on to discover that Homo sapiens Neanderthals and Denisovans coexisted, and made contribution in our genetic ancestry.

This research by Dr. Svante Pääbo Has inspired me and added fuel to the fire by making me impatient to join this fascinating field of anthropology and Paleogenetics. He single-handedly cemented my mind on an aim to bring these methods to India, and with the help of more genome samples, fossils, and efficient sequencing methods, decode our ancestry, where do we, Indians come from? How are we related to those who came before us to each other? Hello?

Dr. Svante Pääbo has left this inquisitive generation with a blueprint to answer these questions whose answers might just be hidden in the very nuclear of our cells.

Tanay Kathuria



Poddar International School CBSE, Nerul.

Chemistry II prize

Noble prices are considered to be the most prestigious and distinguished awards in their respective fields. There are a set of five separate prices which, according to Alfred Nobel's will of 1895 or awarded to who have during the preceding year, made the greatest contribution to mankind.

These prices are awarded in memory of Alfred Noble in the field of physics, chemistry, physiology or medicine, literature and peace. In 1968, Noble prize for economic sciences was later added to the Swedish Noble foundation and is funded by the Swedish central bank. The noble prize in chemistry in the year 2022 was jointly awarded to learn to Morton Meldal and Barry Sharpless for development in click chemistry and bio-orthogonal chemistry.

Click chemistry is not a specific reaction but a way of generating substances by joining their smaller molecular units. In simpler terms, it is the kind of reaction between two chemical groups and alkyne and an azide attached to 2 separate molecules which results in the formation of a chemical bond between the alkyne and the azide, thereby linking the molecules. This reaction somewhat resembles the concept of two wires clicking together and hence the name click chemistry. The notable reaction discovered by mentor mental is the copper catalyzed cyclo addition with a pinch of palladium as catalyst. This reaction resulted in the formation of a pentagonal ring-shaped structure called a triazole (C2H3N3).

Trials are stable and useful chemical compounds. These are found in pharmaceuticals and agricultural chemicals among others. Due to their stability. They are regarded as highly important in biochemistry. However, scientists have a tough time building trazoles from Alka and sides as it leads to the formation of several unwanted by-products. Further, the cost of experiment is increased. Many fold to us but Milel who observed and subsequently published that the copper onions had it to the reaction had controlled the energy of the reaction, thereby achieving the desire result.

On the other side of the globe key Barry Sharpless independent of Meldel published a paper in which he proved that this reaction is workable in water and can be applied to a variety of situation to produce the required structure.

As such the applications of click chemistry are not Restricted only to biochemistry. They are found in chemic, biotic, molecular and pharmacological research. On the industrial scale, this method can be used to produce tailor-made materials that could

conduct electricity, are anti-bacterial can absorb sunlight, protect from ultraviolet radiation and more. Nevertheless, the primary application of click chemistry remains the detection, location and qualification of biomolecules as done by Caroline Bertozzi.

In 2000, Bertozzi Made a remarkable breakthrough when she found the optimal chemical handle that could enable her to conduct reactions within a living cell without affecting it. This chemical handle was an site. She now applied the concept of chemistry by diving, a modified version of the starting reaction (unknown, click reaction), to study the Glycons (a type of bio molecule) in the membrane of cells. However, this technique post sent back for the reaction to proceed present of copper ions versus essential but copper causes toxicity in cells.

Bertozzi Then turn to the ideas of a German scientist who was able to produce an unnatural variant of Salic acid via a click reaction, without causing the cell any damage. It was done by forcing the alkyne into a ring shape. The strain in the molecule due to its ringed structure, provided the energy for the reaction to complete, copper ions were not required.

Bertozzi applied this idea to her reaction and present a novel solution - a copper free, click reaction which was termed as the Strain, Promoter Alkyl Azide, Cyclo addition or SPAAC. She had discovered a bio-orthogonal reaction.

A bio-orthogonal reaction as coined by Bertoni herself into 2003, is a reaction which can be carried out inside a living organism without interfering with the chemical balance within the organism. This allowed real time. Study of bio molecules such as lipids and proteins without causing cellular toxicity. DSPAC reaction could be further used in mapping, tracking and biological labelling of biomolecules. This technique can be applied to detect and locate tumour cells by click reaction of the Glyco is with the reporter molecules on the cell surface. By injecting certain clickable, antibodies and radio isotopes. These tumour cells can be destroyed with minimal damage to the body. This milestone could be there long hunted and awaited permanent cure for cancer.

The commendable efforts of Carolyn Bertozzi, Barry Sharpless, Morten Meldel have provided humans with a solution to nature’s most cryptic riddles. We can study everything nature has to offer the discovery of click reactions and SPAAC is proof that solution to unravel nature’s, mysteries are limited only to the imagination and ingenuity of humans.

Devyani Landge

Ramseth Thakur Public school, Kharghar

Physics, second price

It would not even be an exaggeration to say that this universe is made of billions of trillions of particles, and for all we know, it could also be an understatement.

From centuries, humans have come up with joy, dropping and amazing theories about the universe. And even if we have come up with several theories, they are just pinholes to look at the biggest thing we know.

The evolution from apes to humans, not only enabled us to stand on two feet but also enhanced our cronial capacity. These abilities lead to better survival and spark in thought, which was curious about more than just how to survive.

Beat Galileo or Hypocrites, Arya Bhatta or Nagarjuna ar R Sir Isaac Newton. The world has seen brilliant minds who were way ahead of their time. These genius people have given us deep insights into the scientific mysteries of the universe.

For a long time, the masters that we remember now with great respect, we are not given the recognition. They deserve their great findings were not known to all, and neither was the depth and the importance of such discoveries realised.

In the late 19th century, a Swedish chemist named Alfred Noble passed away and bequeathed all his assets to establish prices in five fields, physics, chemistry, medicine, or physiology literature, and peace. Noble foundation was established in 1900 and the first noble prize was given to on December 10, 1901 commemorating the fifth death anniversary of Sir Alfred Noble.

In year 2022, Alain Aspect, John F Clouser and Anton Zellinger together, were honoured with the noble prize in physics for conducting ground, breaking experiments on the quantum entanglement theory.

But the journey to this shiny golden honour wasn't as a shiny. Quantum entanglement had been much debated and criticised the topic, and the fact that quantum mechanics depends on uncertainty, proving something definite was all the more difficult.

In the 1930s want to entanglement was at the heart of a fiery disagreement with Einstein against the theory and Neel Bohr, and Schrodinger as the promoters. Quantum entanglement is a counter intuitive phenomenon, which explains how to subatomic particles or linked to each other, even if they are separated by billions of

light years, which implies that if a specific property of one of the entangled particle is measured, the other particle when measured gives a complimentary result.

Suppose Annu and Ben, both have one entangled particles each, they both take their particles and go home from the lab and decides to measure the spin of the particle and receives the result as up. Now if Ben decides to measure his particle, he gets down spin as his particle compliments Annu's.

Back in the 1930s, such entanglement implied that information transfer between two particles took place at unimaginably high speeds. This point was against Einstein's theory of special relativity. The basis of which was that speed of light remains constant and no particle at any point can exceed this speed limit.

Einstein believed that all aspects and events in reality must have concrete and fully knowable existence. Everything from a tiny photon to a huge star must have well defined variables to explain its behaviour. He believed that quantum researchers had not been able to find the hidden variable that led to entanglement of particles. On the other hand, the proponents of quantum were finding that reality like entanglement was fundamentally, uncertain, and no set of variables could completely predict the cause of such events. This conflict lead Einstein to Dub quantum as a spooky action at a distance.

In the 1960s, John Bell translated these philosophical conflicts into a scientific and mathematical theory by thought experiment. He propose that if entanglement was dependent on certain variables, the correlation between the results of a large number of measurements must never exceed certain sum. This was named as Bells inequality.

For several years, this theory remained on paper until John F Clouser first bought these imaginations to reality through his experiments in Berkeley, USA. Closer experiments made use of entangled photos and special lenses to detective. He found that these experiments violated Bell's inequality.

But closer experiments were not iron clad. The definite position of lenses led to loopholes, which could still prove Einstein theory is correct.

Enter Alaine Aspect from Paris. Aspect made use of lenses that changed positions randomly in the billion of a second. He made conditions more uncertain, but entanglement, still disobeyed Einstein's beliefs Bell's inequalities.

Though aspects conclusion still had the tiniest loopholes, this finer sliver was narrowed by Antoine Zellinger Iyer from Vienna, Austria. He and his team made use of colours of photos emitted by stars billions of light years away, he found that quantum still violated Bell's inequalities. The team concluded that if they Cosmos was

playing a conspiracy, it would have to start hundreds of years before the birth of experiments or even these labourers who constructed the lab.

Thus, 2022 a line aspect, John F, closer and Zinga together received the noble prize in physics for experiments on entangled photons and violation of Bell's inequality and thereby settled decade along debate creating a new leading pathway for scientist.

These experiments opened the eye of the community on the depth of Schrodinger's statements. Today, quantum in triangle band has found its implication in computing and secure information. Transfer such ideas, experiment and researches are what keep us going telling us that no research or theory is 'the final' and we can always keep exploring. The endless Christmas above us is a symbol of endless wonders, waiting to be exploited.

When that one homo rectors rubbed the stones and lit a fire, a fire was lit, not only before the eyes, but also in the mind. Curiosity kindling to know more about things that lie beyond the senses alone.

In the end, every single constituent of the universe is just a unique combination of atoms and molecules. Such theories make us question about our own purpose in this world which is beyond survival. It is to become one with the universe we are in. Because, even if all particles are separate, they are one as cosmos. We must know that in the end things are more than just to achieve a prize.

" To see the world in a grain of sand, and heaven in wild flower to hold the infinity in the palm of your hand, the eternity in an hour."

ACTIVITY : How big is our solar system?

In one of our previous articles, on Mission Shakti, I had hinted about this issue. How big is our solar system. As a student it is usually difficult to get a feeling of the size of our solar system.

Analogy is a very useful concept in learning and understanding in general. In Science this analogy can also be called as a scaled model. So today let us scale down our solar system to a factor such that our Sun is of radius 10 cm. Which is approximately the size of a football.

In this scale mercury is 0.8 mm (diameter) at a distance of 8.3 m from the 10 cm (radius) Sun on your table. Which would mean if the Sun is on the teacher's table, Mercury is in the middle of the class room.

It is very interesting to calculate the distance of other planets from Sun on this scale (sun having radius of 10 cm) and also distance of moon from Earth, radius of moon, and radii of other planets, all on this scale.

Fill the table given below.

No	object	Diameter (mm)	Distance from Sun (m)
1	Sun	200	-
2	Mercury		
3	Earth		
4	Jupiter		
5	Saturn		
6	Neptune		
7	Moon		

Hence Earth and its moon are a very "local affair" in the solar system.

Also let us see how slowly they move around the Sun.

In next article we will visit the times of rotation and revolution.

Dr. P K Joshi
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DON'T MISS IT

Coming up in Next issue (July-September 2024)

1. More about experiments
2. Student's corner (Essay Competition I Prize)
3. Teacher's page
4. Activity question AND MUCH MORE……

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