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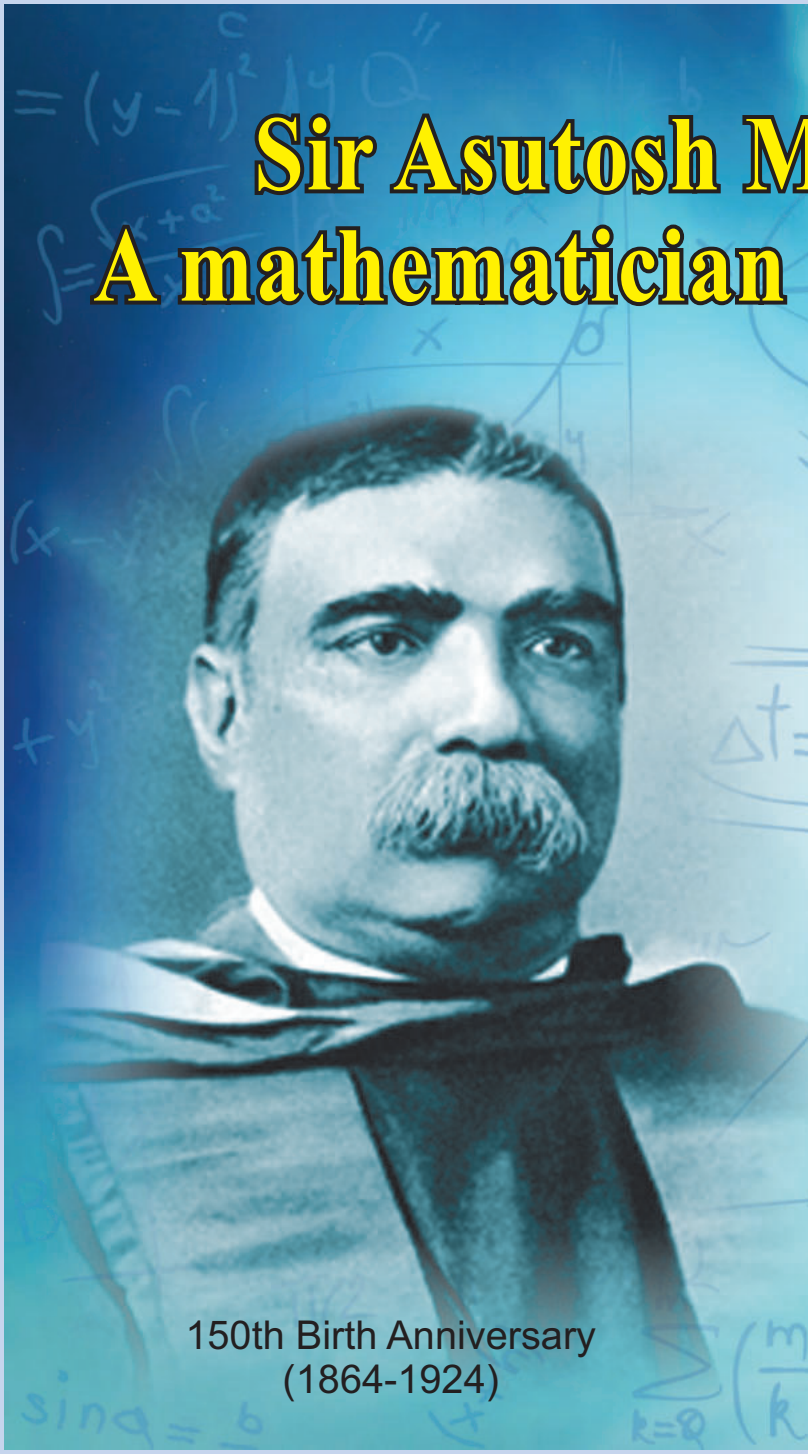
Sir Asutosh Mukherjee: A mathematician par excellence



150th Birth Anniversary
(1864-1924)

... think scientifically, act scientifically... think scientifically, act scientifically... think scientifically, act...

Technology communication and essentials for stakeholder benefit

Dr. R. Gopichandran

The World Economic Forum in January this year highlighted the importance of communication with stakeholders on aspects of emerging technologies (Top 10 Emerging Technologies 2014 January 2014: From the Global Agenda Council on Emerging Technologies http://www3.weforum.org/docs/GAC/2014/WEF_GAC_EmergingTechnologies_TopTen_Brochure_2014.pdf). In this context the Forum dwelt on the well-known fact that not all technologies are without risks, much as several of them promise innovative solutions. Interestingly, the Forum also indicates that gaps in public understanding constrain several of them from realising their potential. The cited document makes interesting reading with a list of some innovative solution providers, alongside stating that it is essential to reach out to stakeholders to resolve perceptions.

An interesting facet of science in this context is its 'moral-unneutrality', as was defined by Charles Percy Snow amongst others. The indisputable fact is that science is clear about the outcomes of its applications through technologies. It does not dilly-dally about the consequences of using technologies, especially in the context of such applications as nuclear energy or pesticides to mention a couple. Public policies that allow the use of technologies have to therefore also duly highlight the limits and limitations of technologies, founding principles of science and local adaptations needed to monitor and derive optimal outputs. Empirical evidences about limits and limitations will further embellish the veracity of claims.

Stakeholder engagement is central to successful uptake and use with appropriate safeguards. It is essential to embed appropriate information on the aspects stated to remove ambiguities in perceptions. More importantly, the consequences of not adopting an alternative over immediate, short-, medium- and long-term periods have to be stated. This obviously leads to the information on trajectories of technology development. A recent discussion at the National Science Centre, New Delhi focussed on the scope of reaching out to citizens on innovations, aligned with India's Science Technology and Innovation Policy 2013. Interestingly, the scope for stimulating interests in innovations was also discussed, creating the opportunity for focussed engagement. While a top-down approach could be to discuss the need for innovations and fostering the spirit of creative thinking in citizens through workshops and campaigns, it is equally important to adopt a bottom-up approach. One of the essential elements of such a bottom up approach will be to scout for innovations and add value to the form and function of such innovations. Laudable initiatives of the National Innovation Foundation, Ahmedabad present a typical case in point. It will be useful to also establish a theme/sector-specific Community of Practitioners (CoP) involving successful innovators. This CoP could be engaged to assist emerging innovators with appropriate information that will help add value to thinking processes. The CoP could also communicate on challenges that need to be tackled in their respective and other domains. This call for action could stimulate thinking further. This call has to be on a regular basis so that people interested in indicating solutions will also be convinced of the need and the takers of such solutions. The latter two aspects could galvanise the momentum of mainstreaming innovations in our country further. The cited reference inspires confidence on the process of communication about technologies. Trajectories and unfinished agendas stimulate further thinking in addition to demonstrating a robust platform for knowledge sharing and visibility.

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Sir Asutosh Mukherjee: A mathematician par excellence

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Sir Asutosh Mookerjee was a great mathematician, educationist and institution builder. Also known as the "Bengal Tiger', he played a pioneering role in elevating education in Bengal to its pinnacle, often in a hostile environment during the height of the British rule.

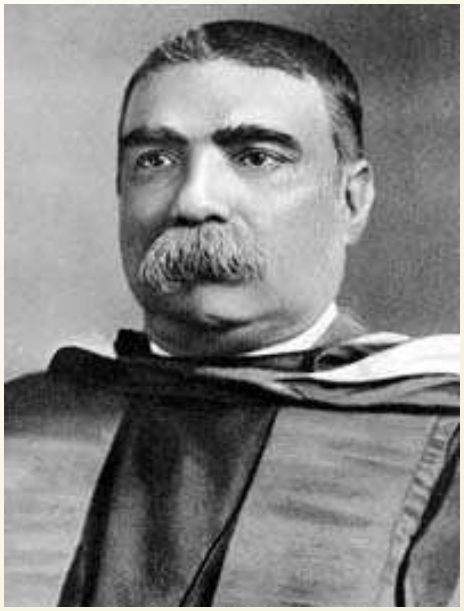
Asutosh Mookerjee was born on 29 June 1864. His father Gangaprasad (1836-1889) was a renowned physician and his mother was Jagattarini Devi. He started his formal education in Chakraberia School of Bhowanipore in 1869. Later, in 1876, he was admitted to South Suburban School in class five. At that time, Headmaster of that school was Pandit Shibnath Shastri (1847-1919), a famous writer, educationist and social reformer. Asutosh passed the entrance examination in 1879 and secured second position. Then he entered the Presidency College (now Presidency University) of Kolkata in the F.A. class where one of his classmates was Narendranath Dutta (1863–1902) who later became world famous as Swami Vivekananda. Asutosh passed F.A. examination in 1881 and stood third. In 1884, he stood first in the B.A. examination, and obtained the Ishan and Vizianagram scholarships and received the Harishchandra Prize. He also stood first in M.A. examination in mathematics in 1885. In 1886, he passed M.A. examination in physics. He was the first student of Calcutta University to pass M.A. examination in more than one subject. He also obtained the Premchand Roychand Scholarship (PRS) after passing a very tough examination.

Asutosh married Jogamaya Devi, daughter of Pandit Ramnarayan Bhattcharya of Krishnanagar, in 1886. During 1887-1891, Asutosh was an examiner for the M.A. examination in mathematics. He obtained a Bachelor's degree in Law in 1888.

Gasper Monge

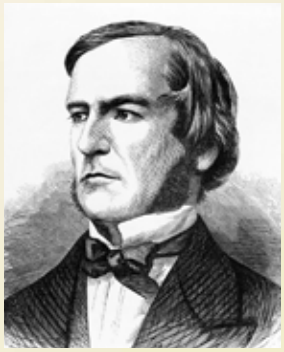
Mathematical works

While he was a student in F.A. class, Asutosh wrote a paper on the 25th proposition in the first volume of Euclid's *Elements*, which stated, "If two triangles have two sides equal to two sides respectively, but have the base (of one) greater than the base (of the other), then they also have one of the angles contained by the equal straight lines greater than the other." Asutosh's paper was published in the mathematical journal *Messenger of Mathematics* of Cambridge.



Sir Asutosh Mookerjee

Geometry and elliptic functions were two main fields of research of Asutosh. During 1887-1889, a number of his research papers, mainly on differential equations of conics, were published. This line of research was initiated by French mathematician Gasper Monge (1746–1818). In fact, analysis by George Boole (1815–1864) on Monge's work prompted Asutosh to search for a geometric explanation of Monge's work. Asutosh's analysis of the comments of Boole, James Joseph Sylvester (1814–1897), and Alan Joseph Cunninghum (1842–1928) were supported by the three mathematicians (*Nature*, vol. 38, pp 318-319, (1888)). In a letter to Asutosh in 1887, the renowned mathematician Arthur Cayley (1821–1895) highly praised this work of him. This work was referred in the famous book *Differential Calculus* by Edwards. Another work of Asutosh on differential equations of trajectories, based on works of Monge and M. Roberts, was mentioned by Forsyth in his book *Differential Equations*. These works of Asutosh were published in *Proceedings of the Asiatic Society of Bengal* during 1887-1889. Two of his papers on Hydromechanics were published in *The Journal of the Asiatic Society* in 1890.



Gasper Monge

For his original works in mathematics, Asutosh was honoured by famous mathematical organisations of many countries. Just after graduation, for his extraordinary proficiency in mathematics, Asutosh was nominated a Life member of the London Mathematical Society in 1884. He was the first Indian member of that organisation. Announcing the news *The Statesman* wrote in its 12 February 1884 issue, "We understand that Babu Asutosh Mookerjee, who stood first at the last B.A. examination, has been elected a member of the London Mathematical Society. He is the first Indian on whom the Society has conferred this honour". The next year, London Astronomical Society elected him as their fellow. In 1887, Physical Society of London, in 1888, Mathematique de France, and Edinburgh Mathematical society, in 1890 Society de Physique of France, and Mathematical Society of Palermo offered their memberships to Asutosh.

The book *Geometry of Conics* written by Asutosh Mookerjee was published from England in 1893. The book was well received by students and several editions were published subsequently. Association for Improvement of Mathematics Teaching,

a prime organisation of Kolkata engaged in development of pedagogy of mathematics (mainly at school level) for more than forty years, and Asutosh Mookerjee Memorial Institute have jointly published a work of Asutosh under the title *On Pott's Euclid*. This book contains a section of a large number (348 in all) of geometrical riders which Asutosh solved between July 1878 and December 1879; i.e., just before his Entrance Examination.

In 1888, Asutosh was invited by Dr. Mahendralal Sarkar, who founded the Indian Association for the Cultivation of Science (IACS), to deliver lectures on scientific topics at the Association. Those lectures were attended by students of post-graduate classes. Asutosh continued this activity till 1891 after which he got too involved in his profession in law to deliver lectures. Sir Gurudas Banerjee (1844-1918), who became the first Indian Vice Chancellor of Calcutta University in 1890, tried his best to create a teaching post for Asutosh, but his attempts failed due to colonial opposition. So, in spite of being a hard core mathematician, Asutosh had no other option than to opt for law as his profession.

Asutosh as a lawyer

Asutosh entered the Calcutta High Court as an advocate in 1888 where his senior was Sir Rashbehari Ghosh (1845-1921), a legal stalwart at that time. In 1894 Asutosh obtained Doctor of Law degree and was appointed by Calcutta University as Tagore Law Professor. He assumed his charge as Justice of Calcutta High Court on 4 June 1904. Apart from a brief period of eight months in 1908 (when he was on deputation due to his engagements related to Calcutta University), Asutosh continuously acted as a judge of Calcutta High Court for 19 years. He also shouldered the responsibility of the Chief Justice of Calcutta High Court for a short term in 1920. During his long tenure as a judge, he gave judgments of as many as 2,500 cases. He retired from Calcutta High Court on 31 December 1923.

Sir Rashbehari Ghosh

Asutosh as an educationist

On 16 January 1889 Asutosh was nominated a Fellow of Calcutta University and in 1906 became its Vice Chancellor, being the second Indian to achieve this honour. He adorned this post for four consecutive two-year terms (1906–1914) and then again during 1921–1923. This period saw the ushering in of a new era in the educational field of Bengal.

Prof. Thomas Holland

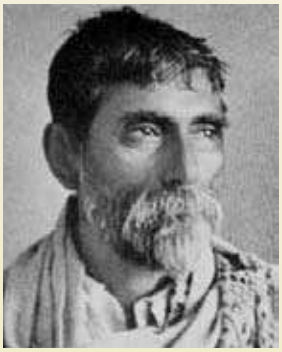
During the tenure of Asutosh as Fellow and Vice Chancellor of Calcutta University, arrangements were made for spreading Law and Ayurvedic knowledge. The medical course was extended for one year so that the new graduates got an opportunity for staying as apprentice in a hospital. Conferring of doctorate degree was introduced as a mark of recognition of fundamental research.

Within a few years, Asutosh collected a large sum of money by appealing to the affluent and honourable persons of the country and that money was spent for constructing the Dwarbhanga Building (in the name of Maharaja Rameswar Singh of Dwarbhanga) as well as for sending students to Europe, USA and Japan for gaining knowledge in the field of industry, science and technology. Being a visionary, Asutosh wanted to expose the students of Calcutta University to the works of great personalities of the world. To fulfil that dream, guest professors were invited to deliver lectures on their own field of research. Prof. Thomas Holland (1868–1947) was invited to deliver a talk on geology. Dr. Gilbert Walker FRS (1868–1958), a famous meteorologist and Director General of Observatories in India, gave a series of extraordinary lectures on mathematical physics. Some other luminaries who came here to deliver such lectures included Herman Olderbrg (1854-1920), Herman Jacobi (1850-1937) and Paul Vinogradof (1854-1925) of Gottingen, Dr. Fosyth and Dr. Quilim of Cambridge, and Japanese professor Yamakami.

C.V. Raman

These lectures were attended by students as well as teachers of colleges and universities. This activity generated a lot of enthusiasm among researchers also. Asutosh founded the Calcutta Mathematical Society on 6 September 1908. This more-than-a-century-old (105 years to be precise) organisation is the first of its kind in Asia, being preceded only by the London Mathematical Society (established in 1865) and the American Mathematical Society (established in 1888). Asutosh served as Founder President of the Calcutta Mathematical Society till his death.

One of the great achievements of Asutosh was to establish the University Law College in Kolkata in 1909. He was successful in creating two posts of professor – one each for mathematics and philosophy. The post for mathematics was named Lord Hardinge Professorship while the other one was in the name of Emperor George V. Dr. Fletcher, a renowned professor of mathematics, was the first Hardinge Professor. Marathi scholar D.D. Kosambi (father of famous mathematician-turned historian D.D. Kosambi) was appointed for teaching Pali language. In June 1912, through generous donation of Rs.15 lakh (in two phases) from famous Barrister Taraknath Palit (1831-1914), Asutosh created two posts of professor – one for physics and another for chemistry. Prafulla Chandra Roy (1861-1944) of Presidency College joined as the first Palit Professor of Chemistry and C.V. Raman (1888-1970), who was awarded Nobel Prize in physics in 1930, became the first Palit Professor of Physics.



Prafulla Chandra Roy

On request from Asutosh, Sir Rashbehari Ghosh, a famous Barrister and senior of Asutosh in Calcutta High Court, donated Rs.10 lakh to the

University of Calcutta. That money was used to create four posts of professor – one each for mathematics, physics, chemistry, and botany (jointly with agriculture). Four professors, viz., Dr. Ganeshprasad (1876-1935) in applied mathematics, Dr. D.M. Bose (1885-1975) in physics, Dr. P.C. Mitra in chemistry, and Dr. S.P. Agharkar (1884-1960) in botany were appointed in those posts. Moreover, as many as eight scholarships of Rs.900 per annum were provided for students. As a mark of recognition of his great achievement, the then British Government conferred Knighthood on Asutosh Mookerjee in 1911.

Meghnad Saha

In 1914 Asutosh founded Indian Science Congress Association (ISCA) for promoting scientific research in India. In his Presidential Address at the first Indian Science Congress held in the premises of Asiatic Society, Kolkata, Asutosh explained the purpose of foundation of ISCA. He said it was, "to give a stronger impulse and a more systematic direction to scientific enquiry, to promote the intercourse of societies and individuals interested in science in different parts of the country, to obtain a more general attention to the objects of pure and applied science and the removal of any disadvantage of a public kind which may impede its progress". ISCA celebrated its centenary in 2013.

On 27 March 1914 Sir Asutosh laid the foundation stone of the University College of Science in Kolkata. In this way, Calcutta University attained a national status under his leadership. His fourth term as Vice Chancellor ended on 31 March 1914 and he was succeeded in that post by Debaprasad Sarbadhikary.

After a lapse of seven years, Sir Asutosh was again appointed as Vice Chancellor of Calcutta University on 4 April 1921. In his second tenure, Sir Asutosh was instrumental in creating five new professor posts – one each for Indian art, physics, chemistry, agriculture and phonetics. These posts were adorned respectively by famous painter Abanindranath Tagore (1871–1951), renowned physicist Meghnad Saha (1893–1956, whose 'Theory of Thermal Ionisation' brought him international repute), internationally famed chemist J.N. Mukherjee (1893–1983), Nagendranath Ganguly (who later received the honour of being selected as a member of Royal Commission of Agriculture), and Suniti Kumar Chatterjee (1890–1977, a great scholar of Bengali literature). In the same year, Asutosh invited great philosopher and scholar Dr. Sarvapalli Radhakrishnan (1888–1975) to join the Calcutta University as 'George V Professor' of Philosophy.

Dr. Sarvapalli Radhakrishnan

Sir Asutosh was a very zealous person and had a sixth sense to spot out budding talents and put them in appropriate positions. For this reason, in spite of various colonial hurdles, he succeeded in lifting Calcutta University to a prestigious position, not only in India but also in the world. For his courage and rigid stance, He was nicknamed the 'Bengal Tiger'.

A severe setback occurred in his life when he lost his dearest daughter Kamala in 1923. Sir Asutosh's tenure as Vice Chancellor was scheduled to end on 3 April of that year. So he delivered his last lecture as Vice Chancellor in the Convocation of Calcutta University on 24 March, 1923. Daughter's death appeared as a lethal shock to him and after a brief illness of only three days, he passed away in the afternoon of 25 May 1924 in Patna.

A multi-dimensional personality

Sir Asutosh Mookerjee was a person having mastery over diverse fields such as mathematics, law and educational reformation. But by heart he was a great mathematician. It is our misfortune that he had to leave the world of mathematics at the prime time of mathematical research for practice of law and afterwards, for acting as an administrator in Calcutta University. No doubt, a golden era of Calcutta University started due to this shifting, but mathematical community of India had to witness the loss of an extraordinary mathematician. Otherwise he could excel as a mathematician of international repute. ■

Of Science and Scientists

Pradeep Kumar Basu
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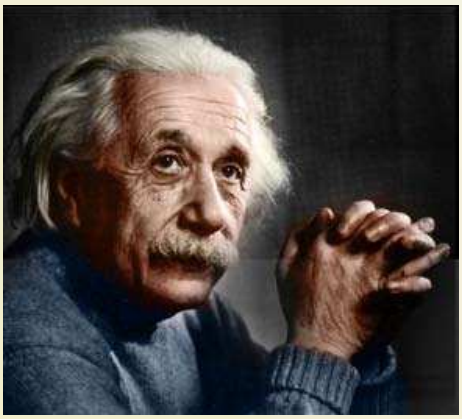
The year 1905 is called the 'miraculous year' (*annus mirabilis*) in physics. In that year, Albert Einstein, an unknown physicist working as a patent clerk in the Swiss Patent Office, published four papers. They were on the theory of special relativity, Brownian motion, equivalence of matter and energy ($E=mc^2$), and photoelectric effect, which introduced the concept of 'quanta' of radiation. He got a lectureship at Berne and later became a Professor at Zurich, but was still not much known among the general public.

In 1915, he published his theory of general relativity. It was a revolutionary theory. One of its predictions was the bending of light by gravity. For bending of starlight by the gravitational field of the Sun, Einstein's theory predicted a value twice that predicted by Newton's theory of gravitation. During a total solar eclipse on 19 May 1919 several scientific groups tried to measure



Albert Einstein

the value of the bending of starlight. British astronomer Arthur Eddington's readings confirmed that Einstein's predicted value was correct. As newspapers splashed this news all over the world, Einstein became an instant celebrity and a household name. After this historic confirmation of Einstein's theory, an interesting incident happened. The year was 1921.The place the central lecture hall of the University of Berlin. The hall was jam packed with learned professors. Even the aisles were choking full with lecturers and research scholars. They had assembled for a lecture by Albert Einstein, undoubtedly one of the greatest scientists of all time. He was to speak on a particular derivation from his theory of general relativity.

Those were the days of chalk and blackboard. Einstein spoke for almost an hour filling up the big blackboards with innumerable equations. Then stopped and summarised his conclusion. Suddenly, from among the students standing at the back, a hand was raised. The young man said, "Professor Einstein, your conclusion is wrong! The assumption you made in that particular step is not tenable with the point made in that other step". There was pin drop silence. Every neck craned back to see the questioner. Who is this upstart who is challenging Einstein? Is he mad? They thought. Einstein was unperturbed. He simply turned back and went over the presentation again. After sometime, he turned towards the audience and said, "Gentlemen. The young man is right. Please forget whatever I have been telling you for the last one hour."

This one incident epitomises what is best in science. It tells us a lot about a great scientist like Einstein: his humbleness, his unswerving adherence to the truth, even at the risk of loss of personal prestige, and it gives us a great lesson about the scientific method: that there is no absolute authority in science.

You may be the greatest scientist under the Sun, but even a new entrant, like in this case, a Russian research scholar named Lev Landau, can challenge you. (Landau later made valuable contribution to the theoretical understanding of superconductivity and won the Nobel Prize in Physics in1962). The laurel goes to the person whosoever is right; that is, whosever's explanation of the phenomena under consideration meets the scientific criteria of theoretical and experimental verification. Thus, science has a built-in mechanism by which all wrong or false beliefs get weeded out automatically.

Dedication and sacrifice

Dedication and sacrifice for science is the hallmark of a great scientist. When Jagadis Chandra Bose joined as a lecturer at Presidency College, Kolkata, he was told he would get half the salary of his European counterparts. He refused to draw salary for two years, till the government relented. He

Jagadis Chandra Bose

had obviously to go through great hardships. He wanted to start research, but the college had no funds for that. On his persuasion they made available an abandoned toilet to him! Bose renovated it and also hired a tinsmith as assistant at his own expense. R&D in modern India was born. It is a mark of Bose's genius that he produced his own state-of-the-art equipment with the help of this one assistant and made his great contributions in electronics, millimetre wave, infrared (IR), and bio-physics. He holds the patent for the first IR detector in the world. He has been recognised as the inventor of the first point contact diode.

Once locked on an idea, scientists work very hard. It is said that Newton and Einstein used to lose weight when working continuously on an idea. Nicola Tesla (1856-1943) was a Serbian-American scientist who made great contributions to the field of electricity. He invented fluorescent lighting, the Tesla induction motor, the Tesla coil, and developed the alternating current (AC) electrical supply system that included a motor and transformer, and 3-phase distribution. It is said that once on a project he would go without food or sleep for days together. It is

said, once he got so exhausted that for several days he lost memory of who he was!

But sometimes, after a long search the answer turns out to be very easy. The Pioneer 10 and 12 spacecraft were launched in 1972 and 1983 respectively. What was intriguing was that both were moving slightly faster than expected. Several explanations were advanced: software errors, fuel leak, solar wind, some unknown gravitational effect, change in the fine structure constant over space, dark matter, etc. In 2012, astrophysicist Slava Turyshev of NASA's Jet Propulsion Laboratory came up with the probable answer. To solve the mystery he went over the data of last 35 years! The explanation? The spacecraft's thermoelectric generators produce heat. This thermal energy gave a slight push to the spacecraft!

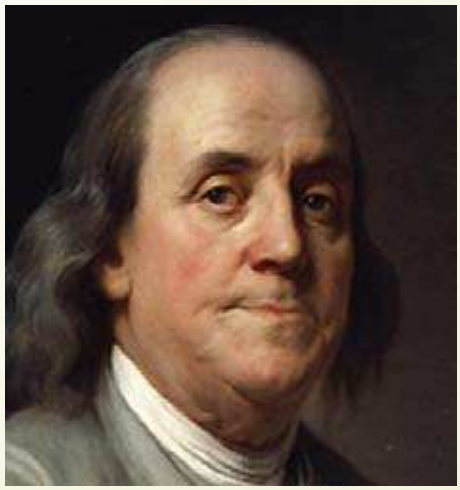
When you try to understand some new scientific concept, it is always a good idea to read it from more than one textbook or research paper. This gives a better understanding and feel of the concept. An interesting incident told by the famous Hungarian-American mathematician and polymath John von Neumann (1903-1957) illustrates this. Neumann was a mathematical prodigy and made outstanding contributions in various areas of mathematics, physics, statistics, computer science and economics. Nobel Laureate physicist Hans Bethe wrote about him, "I have sometimes wondered whether a brain like von Neumann's does not indicate a species superior to that of man."

At the time, von Neumann was teaching a class a particular theorem derived by a certain mathematician. After finishing his explanation, when he looked at his students, none had understood. Then he explained the theorem again by a method as derived by another author. But again none got it. Then he stood thinking for sometime, thought out a new proof on the spot, and presented it. Then he adds one sentence, "Then I understood"! If this can happen to a genius like von Neumann, then where do we stand?

John von Neumann

Taking risks

Experimental scientists have often to deal with dangers like poisonous gases, toxic chemicals, high voltages, explosives, high temperatures, and radioactivity, and so on. Sometimes a slight mistake can be fatal. The annals of science are full of names of scientists who became martyrs for science.



Benjamin Franklin

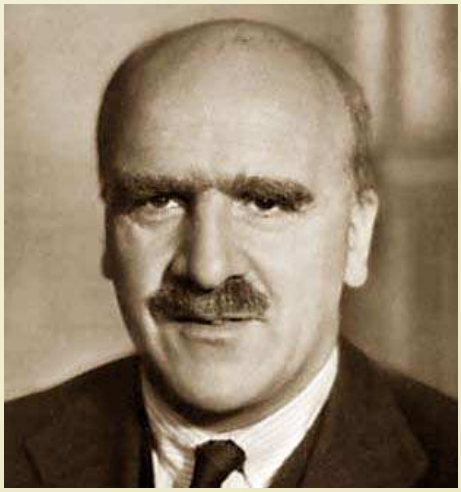
In the early days of electricity, a controversy arose as to whether the electricity generated in the laboratory was the same as the electricity in a lightning stroke. Benjamin Franklin (1706-1790), the famous US polymath and diplomat decided to test. On 15 June 1750, during a thunderstorm he flew a kite with a metal key attached to the thread. This key was connected to a Leyden jar, which Franklin assumed would accumulate electricity from the lightning. He took the precaution of standing on an insulated place under a roof. After the storm, Franklin reportedly received a mild shock by moving his hand near the key, because as he had estimated, lightning had negatively charged the key and the Leyden jar, proving the electric nature of lightning. Unfortunately, while trying to repeat his experiment, some scientists like Georg Wilhelm Richmann lost their lives.

John Scott Haldane (1860-1936), the Scottish physiologist was one experimenter who took great risks. Luckily he survived his experiments. He used to lock himself up in sealed chambers with various mixtures of poisonous gases to study their effect on the human body! He also used his son JBS Haldane as a guinea pig, even when he was quite young. These experiments generated a lot of information about poisonous gases and the effect they have on the human body. One outcome of this was his invention of the first gas mask.

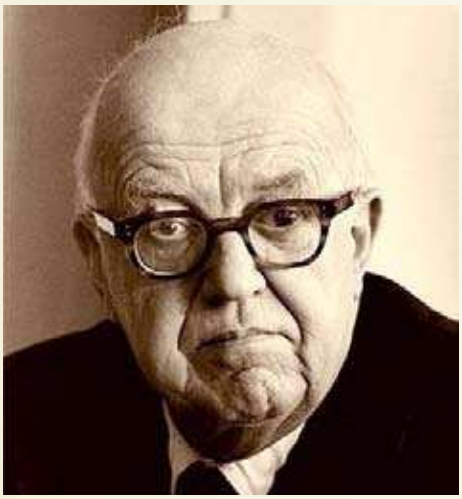
His son, J.B.S. Haldane (1892-1964) followed in his footsteps. To study the effect of decompression, which deep-sea divers suffer from when they surface after a dive, he and his assistants did regular diving with various gas mixtures. In some experiments, he got holes in his ear drum. But, nonchalantly, he writes "the drum generally heals up and if a hole remains in it, although one is somewhat deaf, one can blow tobacco smoke out of the ear in question, which is a social accomplishment!"

Sometimes Nature is not so kind. On 3June1991, two French volcanologists Katia and Maurice Kraft, along with many firemen and photographers were studying the Mt. Unzen volcano in Japan which was in eruption. Suddenly, they were caught in a pyroclastic flow – a fast moving current of superheated gas and rocks moving up to 700 km/h. None survived.

Scientists, when deeply engrossed in their subjects, are sometimes quite absentminded. Paul Erdos (1913-1996) was one of the most prolific mathematicians till date. Once, he was attending a conference in a city where he met another mathematician.



JBS Haldane



C.P. Snow

He asked him from where he was coming. The gentleman replied, "Vancouver." Erdos's face lit up. He said, "Then you must know my good friend Elliot Mendelson." The gentleman smiled and said, "I *am* your good friend Mendelson!"

Two cultures

In 1959, the noted physicist-cum-novelist C.P. Snow (1905-1980) gave a lecture, which he later amplified into a book, titled *The Two Cultures*. His thesis was that though a good scientist knows something of Shakespeare or Rembrandt or the French revolution, the best students of humanities knew very little about science. He felt that this breakdown of communication between scientists and those from the humanities was a major hindrance to solving the world's problems. He wrote, ".....if I had asked an even simpler question – such as, 'What do you mean by mass, or acceleration', which is the scientific equivalent of saying, 'Can you read?' – not more than one in ten of the highly educated would have felt that I was speaking the same language. So the great edifice of modern physics goes up, and the majority of the cleverest people in the western world have about as much insight into it as their Neolithic ancestors would have had."

His thesis has been hotly debated by many scholars. But unfortunately, even after half a century, the situation remains the same, in spite of the fact that science surrounds us much more today than in Snow's time. Food, cosmetics, entertainment, travel, housing, communication are some of the areas where the common man comes directly in touch everyday with the triumphs of science. But what we see today is a decline in the number of students opting for science. Even amongst those few who do, most go for a MBA to get a high paying job in the corporate sector, rather than go for scholarly pursuits like teaching and/or research.

The principal reason appears to be that there is a general feeling that science, specially subjects like physics, are tough. That is true, but so is learning to walk for a new-born baby! You will lose count as to how many times it falls, till it masters the art of walking and then running. So is trying to understand Shakespeare or Kalidasa in the original, or to become a master batsman or bowler, or to lead troops into battle. But we do try to master these skills and win. Then why is this hesitation for science?

There seems to be a lack of general awareness, that knowledge of science confers on you certain skills, not usually available to a non-scientist. It trains you to think logically and systematically. It trains you to observe situations critically and draw logically valid conclusions. These qualities not only help you do science, but also in tackling almost every other problem you face in life. A logical brain also helps you understand other subjects like literature, philosophy, history, etc., relatively easily. That is the reason behind Snow's observation.

Subrahmanyan Chandrasekhar

Just to give one example, Nobel Laureate in Physics, Subrahmanyan Chandrasekhar (1910-95), chose the topic "Shakespeare, Newton and Beethoven or patterns of creativity" for the University of Chicago's Ryerson Lecture in 1975. He was comparing the creativity of persons from three different fields: literature, science, and western classical music! As a preparation, other than listening to Beethoven's works, he read several biographies of Shakespeare, his sonnets, all his great tragedies, and also read several biographies of Beethoven and Newton. In addition, he read biographies of several scientists: Abel, Einstein, Faraday, Maxwell, Michelson, Mosley, Raleigh, and Rutherford. He also read books by mathematicians Jacques Hadamard and Henri Poincare and novelist Thomas Hardy and works of poets Keats and Shelley!

A novelist, a poet, or a composer may not have been able to do justice to the subject of the lecture, because he/she would most probably not have been able to explain Newton! This was the extreme example of a genius like Chandrasekhar, but to a lesser extent, it is true of any good scientist.

I may add that such was Chandrasekhar's devotion to his students that in the 1940's, when he was at the Chicago University's Yerkes Observatory at Williams Bay, Wisconsin, he used to drive 160 km every weekend to teach two students. The reward of his efforts came in 1957, when both the students T.D. Lee and C.N. Yang own the Nobel Prize in Physics!

Knowledge of science does another marvellous thing for you. It opens up to you the great mysteries of this wonderful universe. You get a better understanding of life itself and your role in it. You appreciate how the web of life intertwines us with all the other inhabitants of this planet: the microbes, plants, and animals. The vastness of this creation amazes you, as does the exotic theories scientists are grappling with, to explain its birth and existence. What is the solution to fill this gap between the two cultures? The solutions lie with scientists, parents and teachers. All of them have to come forward to spread general awareness about science among people. Children need to be encouraged to read popular science books, visit science museums where they can do hands-on science, and watch more science programmes on television, to motivate them in science. The seed thus sown in the young minds then needs to be nurtured by good science teachers.

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Metal from Space!

Devendra Mewari
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I was astonished to read a news item which said that the metal of which a statue was made did not belong to Earth! The analysis was done by a German scientist named Dr. Elmer Buchner.

If that metal was not from the Earth then where did it come from? Did it come from the sky? Yes, it certainly did, if one has to believe Dr. Buchner. Probably, 15,000 years ago a meteorite fell on the Chinga river valley situated at the border of Siberia and Mongolia. A statue of Buddha about 24 centimetres high and weighing 10.6 kilograms was made out of that meteorite metal around 1,000 years ago in Tibet. Carved on the upper part of its abdomen is the sign of Swastika. From ancient times, the Swastika has been defended as a symbol of good luck and power. In the eleventh century when the Buddha statue was made, Bon culture was prevalent in Tibet and people were followers of Vajrayana Buddhist god Vaisravana of northern Tibet and they christened it "Iron Man". Some researchers opine that this statue is not of some god but of some warrior holding a sword. Many civilisations of ancient times regarded meteorites as objects being sent by the gods. They used to worship these meteorites and used to make jewellery, daggers, etc. from the metal found in them. "Iron Man" happens to be the world's only statue made from the meteorite metal.

Chinga Meteorite

But, Tibet and Germany are far away from each other. Then, how could this statue reach Germany? It was revealed that prior to the Second World War, on instructions from the chief security personnel, Heinrich Himmler, a team of security group 'SS' members, under the leadership of the zoologist Ernest Schäfer, was sent to Tibet to

Buddhist iron man statue from Tibet

trace the origins of Aryan race. They seized this statue bearing the Swastika mark. In 1938, they brought it to Germany. Since then this statue had disappeared from view. After the death of the owner of the statue it was put on auction in 2007. Dr. Buchner and his associates took the permission of carrying out the chemical analysis of this statue from its new owner. It was finally revealed from the analysis that it was indeed a rare statue and carved from a metal that had extraterrestrial origin. The statue is made of iron and nickel. Any statue made of iron found on Earth does not have so much of nickel content, says the scientists.

Samuel Taylor Colridge

So far, so good. But, where do these meteorites came from? According to scientists, the 'shooting stars' that we occasionally see in the night sky are not the fragments of stars but are the minute fragments of rocks that have come from asteroids or comets. These minute fragments travel with tremendous speed towards the Earth and due to the friction with the atmosphere they get heated to incandescence and start burning. These burning meteorites and the heated air around them appear to us as streaks of light in the still darkness of night. Many of these minute fragments get burnt up in the atmosphere. But, some of the larger fragments do remain intact and are able to hit the Earth. Our ancestors might have seen such fragments falling on the Earth. Perhaps this is the reason why in Atharvaveda there is a verse praying for protection from meteors.

Sometimes, in the sky we can witness spectacular firework-like view among the stars. During such times, one can see not two, four or ten or twenty, but umpteen

Leonide Showers

number of bright streaks of light in the sky. This is known as a 'meteor shower'. It is such a peculiar spectacle to behold that it can fascinate anybody. The scientists say that the famous English poet Samuel Taylor Coleridge might have been fascinated by the Leonid shower originating from the constellation of Leo. This is clearly reflected in the following lines of his poem 'The Rime of the Ancient Mariner', which is the longest poem written by him in his lifetime:

The upper air burst into life!
And a hundred fire-flags sheen
To and fro they were hurried about!
And to and fro, and in and out
The wan stars danced between.
And the coming wind did roar more loud

And the sails did sigh like sedge;
And the rain poured down
from one black cloud;
The moon was at its edge.

Like the Leonids, the meteor shower originating from the Perseus constellation is called Perseid shower while the meteor shower originating from the Gemini constellation is called the Geminid shower. During a meteor shower, the hourly rate of meteor fall can be between 1,000 and 1,80,000.

Most of the meteorites that reach Earth are fragments of asteroids but the meteorites from the Moon and Mars have also been found on Earth. Meteorites found on Earth weigh from a few grams to about 60 tonnes. The speed of a meteorite starts falling at a height of 5 to 25 kilometres in the atmosphere; many a time they are broken into fragments. Such meteorites hit the ground with a speed of 100-200 metres per second. By the time they reach the ground they get cooled down.

If the meteorite is very large then it may cause a huge explosion and lead to the creation of big crates on Earth. Situated in the Arizona State of the U.S. is a crater of this kind with a diameter of 1.2 kilometres and a depth of 200 metres. It is estimated that a meteorite 50 to 100 metres across might have crashed here about 50,000 years ago, creating this crater.

It is said that the Lonar Lake in Maharashtra might also have been formed in this manner, due to the impact of some meteorite or comet remnant. In the desolated Tunguska area of western Siberia, an explosion equivalent to 15 megatons of TNT took place on 30 June 1908 due to an impacting meteorite. All the vegetation within an area of 50 kilometres suffered complete devastation. Before crashing with the Earth the meteorite exploded in air. But, due to the explosion Sun like brightness was created and the sound of explosion could be heard as far away as the city of London. It is estimated that the diameter of this meteorite was about 60 metres.

The scientists say that nearly 65 million years ago a giant meteorite, roughly 10 kilometres across, crashed with the Earth which led to the formation of a crater with a diameter of 180 kilometres. The devastation caused by this meteorite created a huge cloud of dust and smoke that cut off light from the Sun for months and led to the extinction of the dinosaurs. Later mammalians took over the Earth and led to the evolution of the intelligent human race.

According an estimate there are at least 1,000 asteroids more than one kilometre across that occasionally pass through the orbit of the Earth. On an average, during a span of 1 million years one asteroid may strike the Earth. Sometimes, it might happen that some asteroids bigger than this size straying from its normal course may hit the Earth. If that happens, it may prove utterly disastrous. But space scientists are keeping a close vigil on the asteroids wandering towards Earth through the 'Space guard' programme so that they are detected well before they hit the Earth. The course of such asteroids will either be changed or they will be reduced to pieces by causing explosion on them.

Hoba Meteorite

The asteroid named '2012 DA14', which is around 46 metres across, was to pass the Earth at a distance of about 27,000 kilometres on 15 February 2013. It was supposed to come within the orbit of geostationary communication satellites. However, this meteorite passed the Earth safely without causing any harm. According to Vitaly Devydov, a scientist with the Russian Federal Space Agency, an asteroid named 'Apophis' which is 140 kilometres across, will pass the Earth at a distance of 30,000 kilometres on 13 February 2036. There is a possibility of this asteroid smashing into the Earth, but the scientists with the American Space Agency NASA say that this possibility is very remote indeed. However, they have cautioned that the asteroid named '2011 AG5' might hit the Earth in the year 2040.

Of the small and big meteorites found on the Earth so far, the Hoba meteorite that fell on Namibia is the biggest. The weight of this meteorite has been estimated to be more than 60 tonnes. It is estimated that this meteorite hit the Earth around 80,000 years ago. It has been declared as the national monument of Namibia. On 7 November 1492 a meteorite named Ensisheim weighing about 127 kilograms fell on a wheat field of Alsace, France. Poet and satirist Sabastian Brant wrote a poem on this meteorite fall titled, 'Loose leaves concerning the fall of the meteorite'. The German painter and mathematician Albrecht Durer drew a sketch of this meteorite falling on Earth like a fireball. Taking this meteor fall as a good omen, Maximilian I, the son of the Roman Emperor Frederick III, was declared as king. On 14 May 1864 a meteorite fell on Orgueil, a village of southern France. That meteorite is christened Orgueil Meteorite after the name of that village. Twenty fragments of this meteorite could be collected.

In February 1969 a meteorite fell on a village Pueblito de Allende situated in the Chihuahua state of Mexico. It was christened Allende meteorite after the name of the village. It got shattered into numerous fragments before hitting the Earth. The remnants of this meteorite weighing more than two tonnes were collected. On 28 September 1969, a meteorite in the form of a fireball was witnessed over the Australian city Victoria. It broke into three fragments in the mid-air. This meteorite was named Murchison meteorite. The remnants of this meteorite weighing more than 100 kilograms were collected.

Broadly, meteorites are of three types: stony, iron and stony-iron. Of the meteorites found on the Earth so far, 94 percent are stony, 5 percent belong to the iron type, while roughly 1 percent are of stony-iron type.

Meteorites have been falling on Earth since time immemorial and will continue to do so in future as well. However, scientists will either destroy them by causing explosion or change their course in space.

Devendra Mewari is a senior science writer. He has written several popular science books in Hindi and has received coveted national awards for popular science writing.

(Translated by: Abhas Mukherjee) ■

Salkhan Fossil Park:
An Invaluable Geological Heritage

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The Salkhan Fossil Park is located in a village called Salkhan, about 17 kilometres away from Robertsganj in Sonebhadra district of eastern Uttar Pradesh on Varanasi-Renukut highway (SH-5). It is an extremely important site where one can gain valuable insight about the Earth's geological and biological past. The Salkhan Fossil Park presents evidence of the emergence and the initial stages of evolution of life on Earth. The fossils found here represent the oldest fossils of their kind in the world, making Salkhan Fossil Park an invaluable geological heritage not only for India but for the entire world. The fossils in this park generally appear as rings on the boulders.

The Salkhan Fossil Park has brought international recognition not only to the tribal region of Sonebhadra district but also to the state of Uttar Pradesh. Geologists believe that the fossils at Salkhan are approximately

Stromatolite fossils on boulders at Salkhan Fossil Park

1,500 million years old. These fossils date back to the Mesoproterozoic Era according to the geological time scale. American geologists believe that the Salkhan Fossil Park is much older and is three times bigger in area than the Yellowstone Fossil Park in the United States that is about 1,100 million years old.

The Salkhan Fossil Park, which is spread over an area of approximately 25 hectares in the Kaimur Wildlife Sanctuary, comes under the jurisdiction of the state forest department. The circumference of the fossil park is 3.5 kilometres. The forests of this area belong to the category of tropical dry

Enlarged view of a Stromatolite fossil at Salkhan Fossil Park

deciduous forests. The leaves of the woody vegetation or the trees found in these forests fall during the winter season. In the forests, abundance of the following plant species can be seen – kurchie (*Holarrhena pubescens*), salai (*Boswellia serrata*), dhak (*Butea monosperma*), tendu (*Diospyros melanoxylon*), jhingen (*Lannea coromandelica*), sidha (*Lagerstroemia parviflora*), khair (*Acacia catechu*), dhabra (*Anogeissus latifolia*), mahua (*Bassia latifolia*), wild bamboo (*Dendrocalamus strictus*), amla (*Emblica officinalis*), dhabai (*Woodfordia fruticosa*), harar (*Terminalia chebula*), behera (*Terminalia bellirica*), amaltas (*Cassia fistula*), haldu (*Adina cordifolia*) and harsingar (*Nyctanthes arbor tristis*).

Geologists were already aware about the fossils in this region, but local residents and administrative officers had no inkling about them. They first came to know about this fossil park through an article published in the Hindi daily *Hindustan* on 23 August, 2001. Taking cognizance of this newspaper article, the then district magistrate of Sonebhadra, Shri Bhagwan Shankar, formally inaugurated this fossil park as "Sonebhadra Fossil Park" on 8 August 2002. As starting or initial modalities, roads along with permanent resting huts were constructed in the park. For safety purposes, iron fencing was done all along the boundaries of the park. On 5 December 2002 an international workshop related to geology was organised. This workshop, organised under the coordination done by Prof. S. Kumar of Lucknow University, witnessed participation of 42 geologists from both India and abroad. Prominent among the participants were the renowned Canadian geologists Prof. H.J. Hofmann and American geologist Prof. Bruce Runnegar, Dr. J.R. Lyon, and Dr. Linda Sohl.. The geologists established in this workshop that the ring-shaped structures on boulders were nothing else but fossils. Prof. Hofmann was much impressed on seeing the Salkhan Fossil Park. He stated that the fossils of Salkhan Park were the most beautiful and precious things of the world and nowhere in the entire world have there been such beautiful and clear fossils. Prof. Hofmann and other geologists also commented that the fossils of Salkhan were indeed 1,500 million years old.

Salkhan Fossil Park has in its invaluable possession exclusive fossils, but not much

Fossil rings on boulders at Salkhan Fossil Park

attention has been given to its protection, conservation and development. Despite its location of the tourism map of Uttar Pradesh, it is not frequented by visitors. The Yellowstone Fossil Park of America generates revenue of around 300 crore rupees through 4 million visitors. In contrast, the Salkhan Fossil Park is visited only by a handful of researchers and reporters.

The fossils found in Salkhan are algal stromatolites, which represents the oldest fossils found on Earth. The formation of these fossils usually takes place due to

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Kidney stones

Causes, Symptoms and Management

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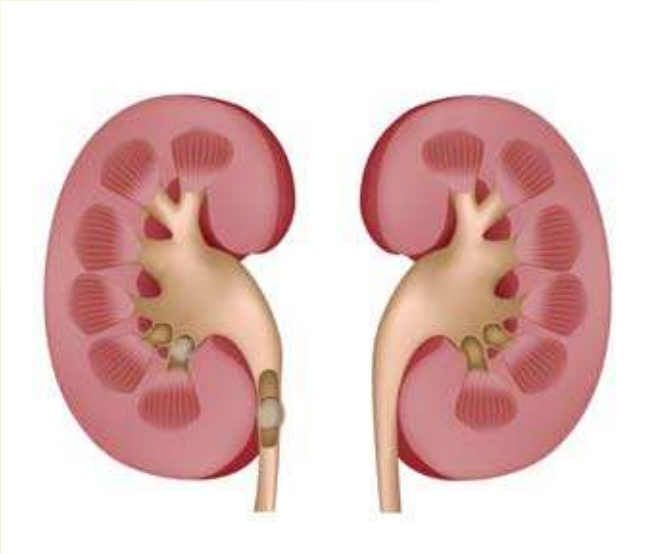
Kidney stones are small, hard deposits that form inside the kidneys. They are made of mineral and acid salts. They can develop due to many causes and can affect any part of the urinary tract — from kidneys to urinary bladder. Often, they form when the urine becomes concentrated, allowing minerals to crystallise and stick together into tiny stone-like structures, or when the chemicals that normally inhibit the crystallisation process are not present. They can take years to form, and can grow very large. Sometimes, they grow so big that they fill the entire centre of the kidney and look like the horns of a stag. Such stones are named the staghorn calculi!



If the stones are small, they may become dislodged from the kidney and move through the urinary passages, eventually passing out of the body in the urine.

Larger stones, however, stay in the kidney but may occasionally move into the ureter, the tube that takes urine from the kidney to the bladder. If a stone becomes lodged in the ureter, it can cause severe pain. A large stone in the kidney is not usually painful, but it can increase the risk of urinary infection.

The treatment of a urinary stone varies with the size of the stone and where it is lodged. If the stone is small, you may need nothing more than to take pain medication and drink lots of water and the stone could pass. In other instances, where the stone is large and is liable to cause damage, you might need surgery.

Your doctor may also recommend preventive treatment to reduce your risk of recurrent kidney stones. More than 70 per cent of people, who grow urinary stones, stand an increased risk of developing them again.

What are the symptoms?

A kidney stone may not cause symptoms until it moves around within the kidney or passes into the ureter. The symptoms usually appear suddenly and may include:

- Severe pain that starts in the back, below the ribs, spreads to the lower abdomen and groin, and may be felt in the genitals. This pain may come in waves and may fluctuate in intensity.
- Frequent, painful passing of urine
- Pink, red or brown urine, indicating blood in the urine
- Cloudy or foul-smelling urine
- Nausea and vomiting
- Persistent urge to urinate
- Urinating more often than usual
- Fever and chills if an infection is present
- Pain caused by a kidney stone may change — for instance, shifting to a different location or increasing in intensity — as the stone moves through the urinary tract.

If a kidney stone is passed in the urine, the pain will subside rapidly. However, if a stone lodges in a ureter, it may cause a build-up of urine, which will then result in swelling of the kidney, a condition that's named hydronephrosis.

When to see a doctor?

Make an appointment with your family doctor if you have any signs and symptoms that worry you. Seek immediate medical attention if you experience:

- Pain so severe that you cannot sit still or find a comfortable position
- Pain accompanied by nausea and vomiting
- Pain accompanied by fever and chills
- Blood in your urine
- Difficulty passing urine

If facilities exist, you may be best served by seeing urologist, a specialist surgeon equipped to handle urinary stones. In the smaller cities and towns, a general surgeon can well handle the situation.

What causes stones?

Kidney stones often have no definite, single cause, although several factors may increase the risk. They usually form when the urine contains more crystal-forming substances — such as calcium, oxalate and uric acid — than the fluid in the urine can dilute. At the same time, the urine may lack substances that keep crystals from sticking together, creating an ideal environment for kidney stones to form.

Inadequate intake of fluid increases the risk of kidney stones. When there is too little water in the body, the kidneys conserve water by forming less urine, and as a result the urine they produce is highly concentrated. People who live in hot climates may be susceptible to kidney stones if they do not drink enough to replace the fluid lost through perspiration.

Some factors may increase your risk of developing kidney stones. They include:

Family history
If someone in your family has kidney stones, you're more likely to develop stones, too.

Past history
If you've already had one or more kidney stones, you're at increased risk of developing another.

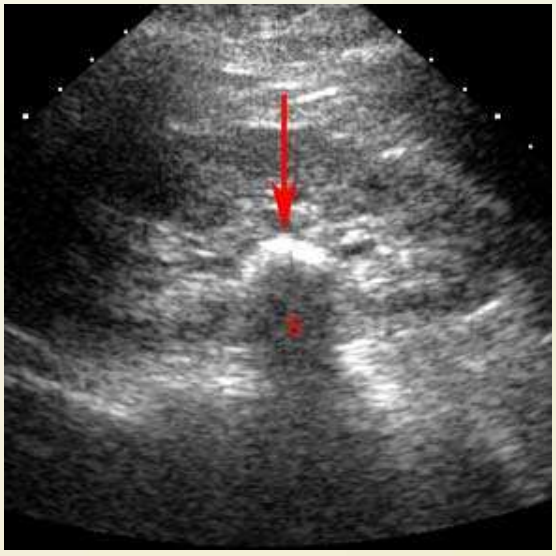
Men are at an increased risk
Men are more likely to develop kidney stones, although an increasing number of women are developing kidney stones.

Be wary of dehydration
Not drinking enough water every day can increase your risk of kidney stones. People who live in warm climates and those who sweat a lot may be at higher risk than others.

Certain diets
Eating a diet that's high in protein, sodium and sugar may increase your risk of some types of kidney stones. This is especially true with a high-sodium diet. Too much sodium in your diet increases the amount of calcium your kidneys must filter and significantly increases your risk of kidney stones.

Being obese
High body mass index (BMI), large waist size and weight gain have been linked to an increased risk of kidney stones.

Digestive diseases and surgery
Gastric bypass surgery, inflammatory bowel disease or chronic diarrhoea can cause changes in the digestive process that affect the absorption of calcium and water, increasing the levels of stone-forming substances in the urine.



Other medical conditions
Diseases and conditions that may increase the risk of kidney stones include renal tubular acidosis, cystinuria, hyperparathyroidism, certain medications and some urinary tract infections.

Types of kidney stones
Urinary stones can be of different types, depending upon the waste products that crystallise out of the urine. Knowing the type of kidney stone helps determine the cause and may give clues on how to reduce your risk of getting more kidney stones. Types of kidney stones include:

Calcium oxalate and phosphate stones
Most kidney stones are calcium stones, usually in the form of calcium oxalate. Oxalate is a naturally occurring substance found in food. Some fruits and vegetables, as well as nuts and chocolate, have high oxalate levels. The human liver also produces oxalate. Dietary factors, high doses of vitamin D, intestinal bypass surgery and several metabolic disorders can increase the concentration of calcium or oxalate in urine.

Calcium stones may also occur in the form of calcium phosphate.

Uric acid stones
Uric acid stones can form in people who don't drink enough fluids or who lose too much fluid, those who eat a high-protein diet, and those who have gout. Certain genetic factors also may increase risk of uric acid stones.

Cystine stones
These stones form in people with a hereditary disorder that causes the kidneys to excrete too much of certain amino acids (cystinuria).

Struvite stones
Struvite stones form in response to an infection, such as a urinary tract infection. These stones can grow quickly and become quite large, sometimes with few symptoms or little warning.

Other stones
Other, rarer types of kidney stones also can occur.

Tests and diagnosis
If your doctor suspects you have a kidney stone, you may have diagnostic tests and procedures, such as:

Blood tests
Blood tests can help assess the kidney function and they may also help identify too much calcium or uric acid in the blood. They can help monitor the health of your kidneys and may lead your doctor to check for other medical conditions.

Urine tests
Tests of your urine, such as the 24-hour urine collection, may show that you're excreting too many stone-forming minerals or too few stone-preventing substances.

Imaging tests
Imaging tests may show kidney stones in the urinary tract. Options range from simple abdominal ultrasound, a noninvasive test; abdominal X-rays, which can miss small kidney stones, to high-speed computerised tomography (CT) that may reveal even tiny stones. Other imaging options include intravenous pyelography, which involves injecting dye into an arm vein and taking X-rays as the dye travels through the kidneys and bladder.

Analysis of passed stones
It is best to catch stones that you might pass. Lab analysis will reveal the makeup of these kidney stones. Your doctor could use this information to determine what's causing your kidney stones and to form a plan to prevent more kidney stones.

Treatment Options

Treatment for kidney stones varies, depending on the type of stone and the cause.

Small stones with minimal symptoms

Generally, small kidney stones do not require invasive treatment. There is a high probability that a small stone may pass by in urine. The following measures may come in handy:

Drinking water and fluids

Drinking as much as 2.0 to 2.5 litres a day may help flush out your urinary system. Unless your doctor tells you otherwise, drink enough fluid — mostly water — to produce clear or nearly clear urine.

Pain relievers

Passing a small stone can cause some discomfort. To relieve mild pain, your doctor may recommend pain relievers such as ibuprofen, diclofenac or naproxen sodium.

Pills

Your doctor may give you a medication to help pass your kidney stone. This type of medication, known as an alpha blocker, relaxes the muscles in your ureter, helping you pass the kidney stone more quickly and with less pain.

Large stones and those that cause symptoms

Kidney stones that cannot be treated with conservative measures — either because they are too large to pass on their own or because they cause bleeding, kidney damage or ongoing urinary tract infections — may require more invasive treatment. Procedures may include:

Extracorporeal shock wave lithotripsy

For certain kidney stones — depending on size and location — your doctor may recommend a procedure called extracorporeal shock wave lithotripsy (ESWL). ESWL uses sound waves to create strong vibrations (shock waves) that break the stones into tiny pieces that can be passed in your urine.

The procedure lasts about 45 to 60 minutes and can cause moderate pain, so you may be under sedation or light anesthesia to make you comfortable. ESWL can cause blood in the urine, bruising on the back or abdomen, bleeding around the kidney and other adjacent organs, and discomfort as the stone fragments pass through the urinary tract. The procedure is also associated with certain undesirable fallouts and you must discuss about them with your doctor before you decide on this line of treatment.

Surgery

To remove very large stones in the kidney, a procedure called percutaneous nephrolithotomy may be needed. This involves surgically removing a kidney stone using small telescopes and instruments inserted through a small incision in your back. You'll receive general anaesthesia during the surgery and be in the hospital for one to two days while you recover. Your doctor may recommend this surgery if ESWL was unsuccessful or if your stone is very large.

Using a scope to remove stones

To remove a smaller stone in your ureter or kidney, your doctor may pass a thin lighted tube, called ureteroscope, equipped with a camera through your urethra and bladder to your ureter. Once the stone is located, special tools can snare the stone or break it into pieces that will pass in your urine. Your doctor may then place a small tube (stent) in the ureter to relieve swelling and promote healing. You may need general or local anaesthesia during this procedure.

Prevention

Prevention of kidney stones may include a combination of lifestyle changes and medications.

You may reduce your risk of kidney stones if you:

Drink water throughout the day

For people with a history of kidney stones, doctors usually recommend passing about 2.5 litres of urine a day.

If you live in a hot, dry climate or you exercise frequently, you may need to drink even more water to produce enough urine. If your urine is light and clear, you're likely drinking enough water.

Eat fewer oxalate-rich foods

If you tend to form calcium oxalate stones, your doctor may recommend restricting foods rich in oxalates. This would reduce the risk of recurrence. The following foods are high in oxalate content and are best avoided:

- Black gram
- Spinach
- Amaranth
- Mustard green
- Curry leaves
- Drumstick leaves
- Mustard leaves
- Gogu (*pitwa* or *ambadi*)
- Lotus stem
- Almonds
- Cashew nuts
- *Amla*, *phalsa*, strawberries and plums
- Rhubarb, beets, and okra (*bhindi*)
- Red chilli
- Chocolate
- Cocoa
- Tea

Choose a diet low in salt and animal protein

Reduce the amount of salt you take and choose non-animal protein sources, such as legumes.

Use caution with calcium supplements

Continue eating calcium-rich foods, but use caution with calcium supplements. Calcium in food doesn't have an effect on your risk of kidney stones.

Ask your doctor before taking calcium supplements, as these have been linked to increased risk of kidney stones. You may reduce the risk by taking supplements with meals.

Eat a low-purine diet

If you have had uric acid stones or hyperuricaemia, it is best to go on a low-purine diet. It can help lower the blood uric acid by about 10 per cent. The following foods cause a rise in serum uric acid:

- Spinach, cauliflower, peas and beans
- Mushrooms
- Whole pulses (*saboot dhals*)
- Dried beans (*chana*, *rajma* and *lobia*)
- Lentils (*masur ki dhal*)
- Organ meats: liver, kidney, sweetbreads (pancreas of calves), meat extracts, poultry, ham, and sausages.
- Seawater fishes including sardines, shrimp, mackerel
- Alcoholic beverages
- Tea, coffee and cola drinks

Keep a good hydration. Drink lot of water, at least ten to twelve glasses in a day. This will help flush the uric acid crystals out of your body.

Medication

Medications can control the amount of minerals and acid in your urine and may be helpful in people who form certain kinds of stones. The type of medication your doctor prescribes will depend on the kind of kidney stones you have. Here are some examples:

Calcium stones

To help prevent calcium stones from forming, your doctor may prescribe a thiazide diuretic or a phosphate-containing preparation.

Uric acid stones

Your doctor may prescribe allopurinol to reduce uric acid levels in your blood and urine and a medicine to keep your urine alkaline. In some cases, allopurinol and an alkalinizing agent may dissolve the uric acid stones.

Struvite stones

To prevent struvite stones, your doctor may recommend strategies to keep your urine free of bacteria that cause infection. Long-term use of antibiotics in small doses may help achieve this goal. For instance, your doctor may recommend an antibiotic before and for a while after surgery to treat your kidney stones.

Cystine stones

Cystine stones can be difficult to treat. Your doctor may recommend that you drink more fluids so that you produce a lot more urine. If that alone doesn't help, your doctor may also prescribe a medication that reduces the amount of cystine in your urine.

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the binding of particles of sediment by microorganisms belonging to the blue-green algae group. Found outside the cells of blue-green algae is a sticky layer that binds the particles of sediment leading to the formation of stromatolite fossils. The sticky substance prevents drying up of the cells. The blue-green algae represent a primitive form of life on Earth.

Despite the importance of the Salkhan Fossil Park, it is neglected due to the apathetic attitude of state government and the local administration. The local people are also responsible for the precarious state of the park because they lack awareness about fossils. This lack of awareness is mainly due to poverty and want of education. As a result, the fossils in the park are totally unsafe.

The barbed wire fence that was installed around the park during inauguration has been stolen due to which the park has become open to animal gazing. The locals move through the park for going to different villages making the fossils vulnerable to damage. People are also surreptitiously taking the fossils to their homes. The smugglers are plundering the park's wealth by selling the fossils in the international market. Illegal mining in the area is an additional threat to this park.

An attempt was made in the recent past by the state forest department to construct a road connecting the fossil park with the highway. However, even this did not prove much helpful in the conservation and development of the park.

The greatest obstruction that comes in the way of conservation, protection and development of the park is the fact that it is situated in an area that is backward and inhabited mostly by tribal people. For the past several decades this area has also been a major centre of Naxal activity. Actually, the Sonebhadra district touches the borders of Bihar, Jharkhand and Chhattisgarh – the states which are backward and infested by Naxal activity.

The deplorable condition of Salkhan Fossil Park is a matter of serious concern which needs immediate attention and calls for positive action for the conservation and protection of the park. For proper conservation of the park, the dire need of the hour is to declare it as 'National Geological Heritage'.

Following the model of the Yellowstone Fossil Park of America, this park needs to be developed as an ideal tourist spot. Development of Salkhan Fossil Park as a tourist spot will not only generate revenue but also help open job opportunities for the unemployed locals. The fact of the matter is that Salkhan Fossil Park is a real boon for Sonebhadra district. The systematic development of this park can not only remove the backwardness of this district but can also help curb the menace of Naxalism.

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(Translated by: Abhas Mukherjee)

Recent developments in science and technology

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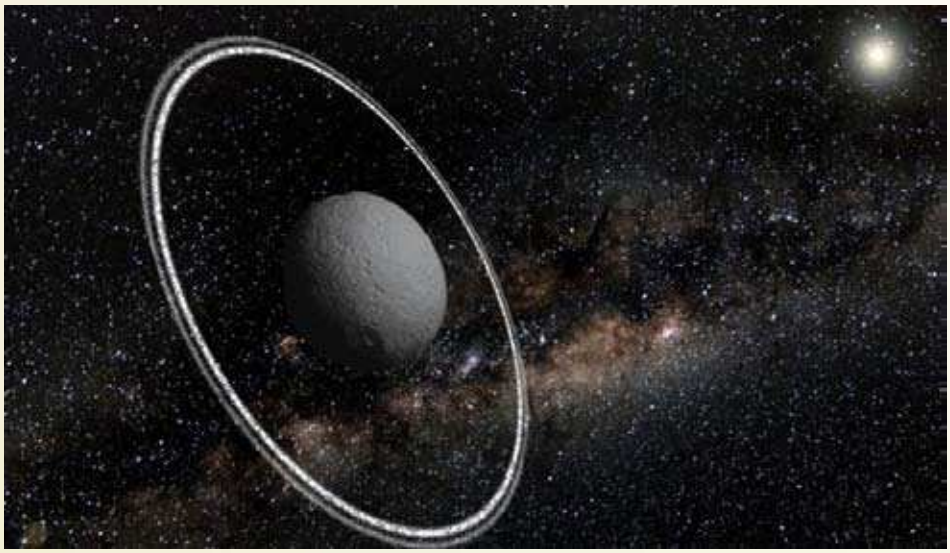
Astronomers discover rings around an asteroid

Till 1977, when the planet Uranus was also found to have rings around it, the only planet of the solar system known to have a ring system was Saturn. Later, rings were also discovered around Jupiter and Neptune, The rings around Uranus were discovered from Earth-based telescopic observation during occultation of a star by the planet. As Uranus passed in front of the star the latter's light was found to dim several times, rather than only once as would happen if there were no rings. The rings around Jupiter and Neptune were revealed in spacecraft images during close fly-bys. The rings of Jupiter were discovered when the spacecraft *Voyager*-1 flew by the planet in 1979. Rings around Neptune were discovered in 1989 when NASA's *Voyager*-2 spacecraft skimmed past the planet. Images from *Voyager*-2 revealed a system of six rings around the planet.



Artist's impression of asteroid Chariklo surrounded by two dense and narrow rings. This is the smallest object in the solar system found to have rings and only the fifth body in the Solar System – after the much larger planets Jupiter, Saturn, Uranus and Neptune – to have this feature. (Credit: ESO)

Now astronomers have found evidence of at least two rings around an asteroid in the outer solar system. The small remote asteroid Chariklo is about 250 kilometres across. It is the largest member of a class of asteroids known as the Centaurs and orbits between Saturn and Uranus in the outer solar system. The discovery marks the first discovery of rings around an object other than a planet and Chariklo is only the fifth solar system object found to have rings around it (*Nature*, 3 April 2014 | doi:10.1038/nature13155).

The rings around Chariklo were discovered in the same way as were the rings of Uranus – by observing the occultation of a star by the asteroid. Telescopes at seven different locations, including the European Southern Observatory's La Silla site in Chile, saw a 12.5 magnitude star called UCAC4 248-108672 disappear for a few seconds on 3 June 2013, as the asteroid passed in front of it. But something unexpected had also happened. The star's light went out briefly twice – a few seconds before and after that main blocking of light. Something around Chariklo was clearly blocking the light too. The only explanation for such observation was the presence of rings. Indeed, by comparing what was seen from different locations the team could reconstruct not only the shape and size of the object itself but also the shape, width, orientation and other properties of the newly discovered rings. The team found that the ring system consists of two sharply confined rings, only seven and three kilometres wide, separated by a clear gap of nine kilometres.

Nobody knows exactly how these rings formed around such a small body, but the authors of the *Nature* paper suggest their origin is likely tied to some sort of collision. A collision could have created a disc of debris that ultimately formed the rings.

Major new 'dwarf planet' discovered

Even as the count of extra-solar planets keeps growing with regular discovery of new candidate planets around distant stars, astronomers have found a new dwarf planet beyond Pluto that also hints at the existence of a much bigger planet (possibly ten times the size of the Earth) hiding even farther out in the dim reaches of the solar system. The new 'dwarf planet', dubbed 2012 VP113, is about 450 kilometres in diameter and

The discovery images of 2012 VP113, the most distant orbit known in our solar system. Three images of the night sky, each taken about two hours apart, were combined into one (arrow). The first image was artificially coloured red, second green and the third blue. 2012 VP113 moved between each image as seen by the red, green and blue dots. The background stars and galaxies did not move. (Credit: Scott S. Sheppard: Carnegie Institution for Science)

orbits the Sun at a distance of 12.4 billion kilometres, or 83 Astronomical Units. (1 Astronomical Unit, or AU, is the average distance between the Sun and the Earth, which is equal to 150 million kilometres.) Before the current discovery, the most distant object orbiting the Sun was the 'dwarf planet' Sedna, also known as 2003 VB12, which was discovered in 2003. Sedna has a diameter of about 1,000 kilometres and orbits the Sun at a distance of around 76 AU, making 2012 VP113 the farthest object known in the solar system.

The term 'dwarf planet' was adopted in 2006 after Sedna's discovery. Because Sedna is larger and further out in space than Pluto – in an area of the solar system called the "inner Oort Cloud" – astronomers established new guidelines for classifying a celestial body as a planet.

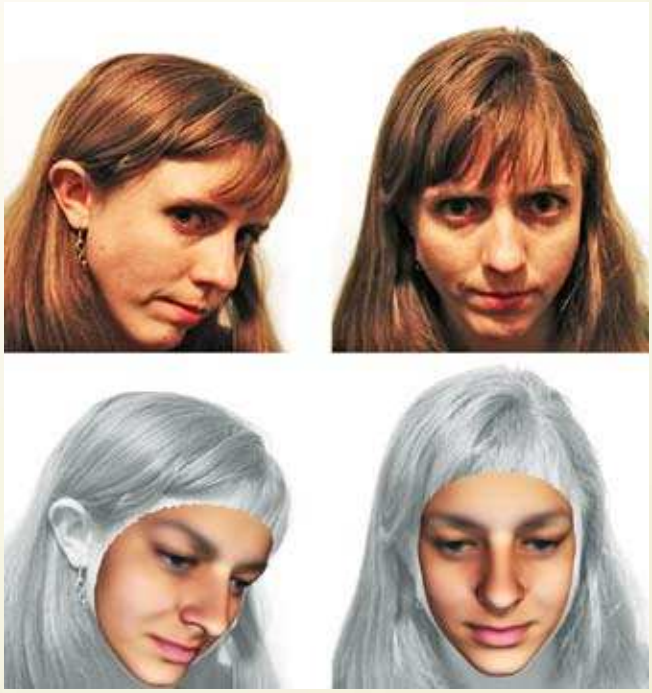
At the general assembly of the International Astronomical Union in August 2006 in Prague, Czech Republic, scientists agreed that for a celestial body to qualify as a planet it must fulfil three conditions: (i) it must be in orbit around the Sun; (ii) it must be large enough that it takes on a nearly round shape; and (iii) it must have cleared its orbit of other objects. The IAU also decreed that the term 'dwarf planet' must always be placed within single quote marks. Neither Sedna nor Pluto met all three criteria, so scientists placed both objects in the new 'dwarf planet' category.

Astronomers divide the known solar system into three distinct regions: the rocky terrestrial planets including the asteroids at 0.39 to 4.2 Astronomical Units (AU) from the Sun; the gas giant planets at 5 to 30 AU from the Sun; and the icy Kuiper belt objects at 30 to 50 AU from the Sun. The Kuiper Belt lies just beyond Neptune's orbit. Beyond this, there appears to be an edge to the solar system where only one object, Sedna, was previously known to exist. But the newly found 2012 VP113 has an orbit that lies even beyond Sedna. The study was done by astronomer Scott Sheppard from the Carnegie Institution for Science in Washington, D.C., and Chadwick Trujillo from the Gemini Observatory in Mauna Kea, Hawaii (*Nature*, 27 March 2014 | doi:10.1038/nature13156). Incidentally, Trujillo was one of the astronomers who discovered Sedna in 2003.

According to the astronomers, 2012 VP113 is likely one of thousands of distant objects that are thought to form the so-called inner Oort cloud. Their work also indicates the potential presence of an enormous planet, perhaps up to 10 times the size of Earth, not yet seen, but possibly influencing the orbit of 2012 VP113 as well as other inner Oort cloud objects.

Identifying faces from DNA sample

Scientists have developed a technique that can be used to create mug shots of criminal suspects from DNA samples found at the scene of a crime. DNA samples are already being used by forensic scientists to carry out DNA-fingerprinting and also make some inferences about the appearance of crime suspects, including their racial ancestry and some shades of eye and hair colour. In 2012, a team led by Manfred Kayser of Erasmus University Medical Centre in Rotterdam, the Netherlands, identified five genetic variants which had detectable effects on facial shape. But till recently, it was not possible to correlate genetic variation to the actual appearance of a face. The recent work shows that it is indeed possible. The research was done by a team of scientists led by population geneticist Mark Shriver of Pennsylvania State University in USA (*PLOS Genetics*, 20 March 2014 | doi: 10.1371/journal.pgen.1004224).



Real photographs of the face of a female (top) and the same face reconstructed from DNA (bottom). (Credit: New Scientist)

For their research, the scientists measured the face shapes in population samples with mixed West African and European ancestry from three locations – the United States, Brazil, and Cape Verde Islands in the central Atlantic Ocean off the coast of Western Africa. They took high-resolution images of the faces of 592 randomly selected volunteers from these locations and used these images to create 3D models of digital faces on computer. Then they superimposed a mesh of more than 7,000 points onto the scanned 3D images and recorded the precise location of each point. They also developed a statistical model to consider how genes, gender and racial ancestry affect the position of these points and therefore the overall shape of the face; for example, whether the nose was flatter, or the cheekbones wider. They used trained workers to rate the faces on a scale of masculinity and femininity, as well as on their probable ethnicity.

Next the researchers tested each of the 592 volunteers for 76 genetic variants in genes that were already known to cause facial abnormalities when mutated. They reasoned that normal variation in genes that can cause such problems might have a subtle effect on the shape of the face. They also analysed the genomes of the volunteers to identify points at which the DNA differed by a single base, called a single nucleotide polymorphism (SNP), and finally pinpointed 24 SNPs across 20 genes that they found were significantly associated with facial shape.

According to the researchers, "much more work is needed before we can know how many genes will be required to estimate the shape of a face in some useful way and many more populations need to be studied before we can know how generalisable the results are." Eventually, the researchers believe that they might be able to approximate the image of a parent from the DNA of children. On a more practical level, law enforcement agencies might be able to create a "mug shot" from DNA to identify both victims and criminals.

Dual role of carbon dioxide in photosynthesis

Photosynthesis is the conversion of light energy into chemical energy in cells that contain the green pigment chlorophyll. Photosynthesis occurs in most plants and algae and in some bacteria and protozoans. The process is also called carbon fixation, because it also produces carbon compounds from carbon dioxide in air that store the chemical energy for use in cell growth.

Photosynthesis is not a single chemical reaction, but rather a set of chemical reactions. Two main chemical reactions occur in photosynthesis. One takes place only in the presence of light and is called the 'light reaction'; the other can occur with or without light and is called the 'dark reaction'. The light-dependent reaction occurs when solar energy is captured to make a molecule called ATP (adenosine triphosphate). The dark reaction occurs when the ATP is used to make glucose (the Calvin Cycle).

New research shows that the oxygen liberated during photosynthesis in green plants comes from the splitting of water by bicarbonate ion formed from carbon dioxide.

The overall reaction is:

$6CO_2 + 12H_2O + \text{light} \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$

It has been known that during photosynthesis, carbon dioxide is converted (reduced) into sugar (carbohydrates) and oxygen in released. Carbohydrates are the most important direct organic products of photosynthesis in the majority of green plants. New research now shows that in addition to producing sugar, carbon dioxide also plays a key role in splitting of water during photosynthesis. Researchers led by Johannes Messinger, Professor at the Department of Chemistry at Umeå University in Sweden have found that carbon dioxide, in its ionic form bicarbonate, has a regulating function in the splitting of water in photosynthesis and that the oxygen released during photosynthesis comes from water and not from carbon dioxide, as was believed earlier. This means that carbon dioxide has an additional role apart from being reduced to sugar – in splitting water to produce oxygen (*Proceedings of the National Academy of Sciences*, 7 April 2014 | doi: 10.1073/pnas.1323277111). The researchers found that the bicarbonate ion (HCO_3^-) acts as a mobile proton acceptor that helps transport the protons, ultimately resulting in a light-driven production of oxygen and carbon dioxide.

For the study the research group had developed a very sensitive technique based on 'Membrane Inlet Mass Spectroscopy' (MIMS) that can be used to measure the production of gases in photosynthetic samples under analytically controlled conditions. (MIMS is a fully automated quantitative gas analysis system with a temperature-controlled membrane introduction inlet for fast and repeatable analysis of gases and dissolved gases in liquids at the parts-per-trillion level.) With this sensitive method they could detect relatively large amounts of carbon dioxide in the mass spectrometric experiments.

According to Messinger, "It seems as if two different carbon species, both derived from the carbonic acid cycle, have got the optimal chemical properties to be used as terminal electron acceptor (CO_2) in the very end of the photosynthetic reaction and at the same time as proton acceptor (HCO_3 –) in the very beginning of the photosynthetic reaction." These findings add a previously unidentified component to the regulatory network of oxygen-producing photosynthesis and settle the more than 50-year-long quest for the function of CO_2/HCO_3^- in photosynthetic water oxidation. The results open up a new research field where researchers can investigate possible biological and ecological consequences of the dual role of carbon dioxide. ■

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