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DREAM 2047

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VP News

Hindi *Pakhwara* at Vigyan Prasar

Every year Vigyan Prasar organises Hindi *Pakhwara* during the period 15-30 September 2006. During this period a variety of competitions and programmes are organized for its members. On 15 September 2006, a workshop on popular science writing in Hindi was organized. The workshop was inaugurated by Dr. Vinay B. Kamble, Director, Vigyan Prasar. He observed that Hindi is a vibrant language of 400 million people of our country and every effort should be made to popularize science in Hindi. The participants included renowned science writers and editors, viz. Prof. Shiv Gopal Mishra, General Secretary, Vigyan Prishad, Prayag, Allahabad and Editor, Vigyan; Dr. R.D. Sharma, Ex Director, DIP, ICAR; Shri Subhash Lakhera, Scientist, DRDO, New Delhi; Dr. Pradeep Kumar Mukherjee, Reader, Desh Bandhu College, Delhi University; Shri R.K. Anthwal, Editor, Avishkar, NRDC, New Delhi; Dr. S. Mahanti, Scientist 'F', VP and Shri Devendra Mewari, Fellow, VP. The participants deliberated at length on various aspects of popular science writing in Hindi. Dr. R. D. Sharma spoke on how bio-technology could be popularised in Hindi. The participants spoke about their experiences on science popularisation and it was emphasized that there is ample scope for popularization of science in Hindi. The *Pakhwara* celebrations would conclude with various competitions like essay writing, extempore speech and other activities for members of Vigyan Prasar family.

Workshop in progress on science popularisation in Hindi

Earlier, on 14 September, 2006 "Hindi Diwas", a discussion was organized on development of a practical science Dictionary for science communicators. This is an ambitious project of Vigyan Prasar under which 15,000 scientific terms have already been compiled by Vigyan Parishad, Prayag.

Hindi Diwas
(L to R) Dr. V.B. Kamble, Dr. Shiv Gopal Mishra, Shri V.K. Joshi, and Dr. R.D. Sharma during a discussion

Inside

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

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Editor : Dr. V.B. Kamble

Dwarfed – Still a Wanderer

For over seventy five years Pluto has been among the nine planets thought to make up our Solar System. From our early childhood, we have recognized Pluto as the tiniest and the farthest member of the Sun's immediate family. In 1930, the twenty-two year old American astronomer Clyde Tombaugh discovered Pluto at Lowell Observatory in Arizona. On 24 August 2006, the International Astronomical Union (IAU) at its meeting in Prague stripped Pluto of its planethood, and the number of planets was shrunk to eight. It may be of interest to note that the same body had recognized it as a planet in 1930! Pluto may no longer find a place in textbooks as the ninth planet in our Solar System. It would rather be called a "dwarf planet". What prompted the scientists to strip Pluto of its status as a planet, anyway?

The word "planet" comes from the Greek word for "wanderer", meaning that planets were originally defined as objects that moved in the sky with respect to the background of fixed stars. When discovered, Pluto was classified as a planet. This was because Pluto was the only known object in the Kuiper Belt – an enigmatic zone beyond Neptune teeming with comets and other planetary objects, in the outer reaches of the known Solar System. In fact, we now know that there are a large number of small objects in the Kuiper Belt beyond the orbit of Neptune, roughly the same size as Pluto. In 1978 Pluto was found to have a moon – rather a companion – that was named Charon. Pluto's orbit is highly eccentric. At times it is closer to the Sun than Neptune (as it was from January 1979 to February 1999). Observations also have shown that Pluto's orbital inclination is much higher compared to the other planets. Hence, Pluto travels well above and below the ecliptic – the plane of the Solar System in which the Earth and the other seven planets orbit the Sun. Surely, Pluto is quite different from the rest of its big brothers. This is why some astronomers began casting aspersions over Pluto's status as a planet.

Ever since the beginning of the 21st century, the discovery of nearly Pluto-sized objects in our outer Solar System has caused debates over whether Pluto should be considered a planet at all. In 2002, astronomers discovered an object called Quaoar, which like Pluto, lies beyond the orbit of Neptune. Quaoar measures about 1,250 kilometres in diameter, and is larger than any previously known asteroid and roughly the size of Pluto's moon Charon (diameter 1,212 kilometres). In 2004, astronomers found another planet-like object three times farther from the Sun than Pluto. The object, called Sedna, appeared to be about 1,800 kilometres in diameter or about three-fourths the size of Pluto. When Michael Brown of the California Institute of Technology discovered 2003UB313 (earlier he fondly called it Xena) – now officially named Eris, a Kuiper Belt object larger than Pluto, many astronomers openly started debating if Pluto still had any right to continue as a planet. On the other hand many argued – if Pluto can be a planet, why not 2003UB313, Sedna, Charon and Quaoar? And why not Ceres – the first asteroid to be discovered (diameter of 913 kilometres) in 1801? This is how astronomers began feeling a compelling need to evolve criteria that could help them classify an object as a planet.

The IAU members gathered at the 2006 General Assembly toiled to reach a consensus in an effort to define a "planet". First, it was argued that a celestial body can be defined as a planet if it is in orbit around a star while not being itself a star or a satellite. Second, the object must be large enough for its own gravity to pull it into a nearly spherical shape. The shape of objects with mass above 5 x 10^{20} kg and diameter greater than 800 km would normally be determined by self-gravity, but all borderline cases would have to be established by observation. With these two criteria, there would be 12 planets in our Solar System – Mercury, Venus, Earth, Mars, Ceres, Jupiter, Saturn, Uranus, Neptune, Pluto, Charon and 2003UB313 (Eris).

If in future, more Kuiper Belt objects are found satisfying these two criteria (for which the probability is certainly not small!), it would further change the number of planets, and hence an element of uncertainty would prevail as regards the number of planets. Hence one more stringent criterion was added to the definition of the planet, according to which, the body "must have cleared its neighborhood" around its orbit – in addition to the previous two criteria. Incidentally, the phrase "clearing the neighborhood" refers to an orbiting body "sweeping out" its orbital region over time, by gravitationally interacting with smaller bodies nearby. Over many orbital cycles, a large body will tend to cause small bodies either to accrete with it (grow together into one), or to be disturbed to another orbit. As a consequence, it does not then share its orbital region with other bodies of significant size, except for its own satellites, or other bodies governed by its own gravitational influence. Pluto (or its companion Charon) could not meet the third criterion. At times, it comes within the orbit of Neptune. Further, Pluto lies within the Kuiper Belt and hence is surrounded by myriads of Kuiper Belt objects - it has, therefore, *not* cleared its neighborhood. This is similar to

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Euclid

The Author of the Best Known Textbook

❑ Subodh Mahanti
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Euclid is one of the best known and most influential of classical Greek mathematicians but almost nothing is known about his life. He was a founder and member of the Academy in Alexandria, and may have been a pupil of Plato in Athens. Despite his great fame Euclid was not one of greatest of Greek mathematicians and not of the same calibre as Archimedes.

A Dictionary of Scientists, Oxford University Press, 1999

Euclid offers strange contrasts: although his work dominated mathematics for over 2,000 years, almost nothing is known of his life and personality.

The Cambridge Dictionary of Scientists, Cambridge University Press, 2002

His (Euclid's) *Elements* of geometry…is the earliest Greek mathematical treatise to have survived, and is probably better known than any other mathematical book, still being used as the basis of school textbooks in the early part of the 20th century. It was the first mathematical book to be printed and has stood as a model of rigorous mathematical exposition for centuries.

Chambers Biographical Dictionary, Chambers Harrap Publishers Ltd, 1997

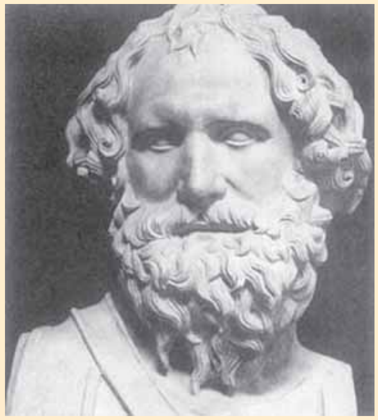
It is generally believed that Euclid, also known as Euclid of Alexandria, was a Greek mathematician. He lived in Alexandria, Hellenistic Egypt. He is regarded as the "father of geometry". His most popular work, *Elements*, is considered to be the most successful textbook of all time. He summarised the most of the Greek mathematics and geometry known during his time.

We do not have any information about Euclid's life. According to some Arabian authors Euclid was the son of Naucrates and he was born in Tyre. However, historians of mathematics have not accepted this version and consider it fictitious. According to some others Euclid was born at Megara. This kind of belief perhaps arose from the fact that Euclid (or Eucleides) of Megara (which flourished around 390 BC), a philosopher, lived about 100 years before Euclid the mathematician. There are some stray remarks about Euclid. We do not know the veracity of these remarks. All accounts of Euclid describe him as a kind, fair, patient man who quickly helped and praised the works of others. The Greek mathematician Pappus of Alexandria (4th century AD) wrote: "... most fair and well disposed towards all who were able in any measure to advance mathematics, careful in no way to give offence, and although an exact scholar not vaunting himself." Stobaeus wrote: "... someone who had begun to learn geometry with Euclid, when he had learnt the first theorem, asked Euclid 'What shall I get by learning these things?' Euclid called his slave and said 'Give him three pence since he must make gain out of what he learns'.

Euclid

We have almost no knowledge about Euclid's life, but unlike the works of other ancient Greek mathematicians his works survived. The most celebrated work attributed to Euclid is the *Elements*. It seems Euclid wrote other books, which no longer exist. However, we know about these books from the writings of later authors. Among the lost books of Euclid are: *Data* (on properties of figures), *Surface Loci* (two books), *Porisms* (a three-book work), *Conics* (four books), *Pseudaria* (Book of fallacies) *Phaenomena* (an elementary introduction to mathematical astronomy), *On Divisions of Figures* (on constructions), *Optics* (the first Greek work on perspective), and *Elements of Music*.

It is believed that Euclid lived in Alexandria around 300 BC. It should be noted here that after the death of Alexander the Great (356-323 BC), his generals divided up his kingdom. Egypt, the country in which Alexander the Great himself had founded the new city of Alexandria, came under the rule of Ptolemy I (c. 367-283 BC). In Alexandria, Ptolemy I, who was one of the greatest generals of Alexander the Great, established a library and a school and he invited Euclid to teach mathematics in his newly established school. Following Euclid many great mathematicians came to Alexandria. The fact that Euclid lived in Alexandria is derived from a passage in Proclus's commentary on the first book of *Elements*. Proclus (c.410-485 AD), a Greek Neoplatonic philosopher, wrote: "All those who have written histories bring to this point their account of the development of this science. Not long after these men, came Euclid, who brought together the *Elements*, systematizing many of the theorems of Eudoxus, perfecting many of those of Theatetus, and putting in irrefutable demonstrable form propositions that had been rather loosely established by his predecessors. He lived in the time of Ptolemy the First, for Archimedes, who lived after the time of the first Ptolemy, mentions Euclid. It is also reported that Ptolemy once asked Euclid if there was not a shorter road to geometry than through the *Elements*, and Euclid replied that there was no royal road to geometry. He was therefore later than Plato's group but earlier than Eratosthenes and Archimedes, for these two men were contemporaries, as Eratosthenes somewhere says. Euclid belonged to the persuasion of Plato and was at home in this philosophy; and this is why he thought the goal of the *Elements* as a whole to be the construction of the so-called Platonic figures." Proclus lived in the fifth century AD; that is, 800 years after Euclid's death. The validity of Proclus' assertion that Archimedes referred to Euclid has been challenged on the ground that in those days such practices were not in vogue. This kind of counter argument cannot be proved or disproved with certainty. However, it is generally believed that Euclid wrote his works after Plato's pupils such as Eudoxus of Cnidus (408-353 BC) and before Archimedes.


Archimedes

Like in case of the Greek philosopher and mathematician Pythagoras (c. 580-c.500 BC) the existence of Euclid as a historical character has not been proved beyond doubt. It is true that it is generally assumed that there was a mathematician named Euclid who wrote the *Elements.* This is because for over 2,000 years no serious proof came forward to prove it otherwise. While it is true that there may be variation in style between some books of the *Elements*, but then it is not uncommon for an author to change his style. It has been argued that perhaps Euclid alone did not write all the works attributed to him. He was a leader of a group of mathematicians who together wrote the *Elements* and other works attributed to Euclid. We virtually do not know anything about Euclid. Even there is no preface to any of his works. And so it is not unexpected that even the very existence of Euclid has been doubted. It has been argued that the works attributed to Euclid were actually written by a group of Alexandrian mathematicians 'who took the name Euclid from the historical character of Euclid of Megara who lived about 100 years earlier.' In the distant past it was a common practice for the lesser-known authors to attribute their works to a known personality.


Eudoxus of Cnidus

The most famous work attributed to Euclid was his treatise on mathematics called the *Elements*. It remained the chief source for mathematical teaching for 2,000 years. Euclid's *Elements* were a compilation of Greek mathematics and geometry. Today there is no way of knowing how much of the work included in the *Elements* is Euclid's original work. Many of the theorems found in the *Elements* can be traced to previous thinkers including Euxodus of Cnidus, Thales (c.620-c.555 BC), and Pythagoras. However, the format of the *Elements* belongs to Euclid alone. Probably, there is no result in the *Elements* that was first proved by Euclid. He compiled the existing knowledge on the subject. There are definite proofs that while compiling the *Elements*, earlier works were used. The first printed copy of the *Elements* appeared in 1482. The *Elements* was translated into both Latin and Arabic and is the earliest similar work to survive, basically because it is far superior to anything previous.

There are 13 books in the *Elements*. The *Elements* begins with definitions and five postulates. Books one to six deal with plane geometry. Books one and two describe the basic properties of triangles, parallels, parallelograms, rectangles and squares. Book three discusses the properties of the circle. Book four deals with problems about circles. Book five lays out the work of Eudoxus of Cnidus on proportion applied to commensurable and incommensurable magnitudes. Book six looks at applications of the results of book five to plane geometry.

Books seven to nine are concerned with number theory. In particular, book seven is a self-contained introduction to number theory and contains the Euclidean algorithm for finding the greatest common divisor of two numbers. Book eight looks at numbers in geometrical progression.

Book ten, based on earlier work of the Greek mathematician Theaetetus (c.414-c.369 BC) deals with the theory of irrational numbers.

Books eleven to thirteen develop the subject of three-dimensional geometry. In book eleven the basic definitions needed for the three books together are given. The theorems then follow a fairly similar pattern to the two-dimensional analogues previously given in books one and four. The main results of book twelve are that circles are to one another as the squares of their diameters and that spheres are to each other as the cubes of their diameters. The last book of the *Elements* or book thirteen, which is mainly based on an earlier treatise *Theaetetus* by Plato, discusses the properties of the five regular polyhedra and gives a proof that there are precisely five.

The first printed version of the *Elements* appeared in 1482. Since its first publication, more than 1,000 editions were printed. Commenting on the importance of the *Elements*, B L van der Waerden, a mathematician and historian of mathematics wrote: "Almost from the time of its writing and lasting almost to the present, the *Elements* has exerted a continuous and major influence on human affairs. It was the primary source of geometric reasoning, theorems, and methods at least until the advent of non-Euclidean geometry in the 19th century. It is sometimes said that, next to the Bible, the "Elements" may be the most translated, published, and studied of all the books produced in the Western world." Further, Thomas L. Heath, the author of *A History of Greek Mathematics* (Dover Publications, New York, 1981) wrote: "This wonderful book, with all its imperfections, which are indeed slight enough when account is taken of the date it appeared, is and will doubtless remain the greatest mathematical textbook of all time. ... Even in Greek times the most accomplished mathematicians occupied themselves with it: Heron, Pappus, Porphyry, Proclus and Simplicius wrote commentaries; Theon of Alexandria re-edited it, altering the language here and there, mostly with a view to greater clearness and consistency..." (both van der Waerden and Heath are quoted in *Euclid* by J J . O'Connor and E. F. Robertson, www-groups.dcs.st-and.ac.uk/~history/Printonly/Euclid.html)

Eratosthenes

Euclidean geometry is based on a number of theorems and which in turn can be derived from five postulates (axioms) and five common notions. Jan Gulberg presents these postulates and notions as follows:

The Five Postulates

1. Exactly one straight line can be drawn between any two points.
2. A straight line can be continued infinitely.
3. With any point as centre, a circle with any radius may be described.
4. All right angles are equal.
5. Through a given point outside a given straight line, there passes only one line parallel to the given line; that is, such a line does not intersect the given line.

The Five Common Notions

1. Things equal to the same thing are equal.
2. If equals are added to equals, the wholes are equal.
3. If equals are subtracted from equals, the remainders are equal.
4. Things which coincide with one another are equal.
5. The whole is greater than a part.

The notions are not specific geometrical properties but rather general assumptions, which allow mathematics to proceed as a deductive science

All the theorems of Euclidean geometry are based on these postulates and notions. In the 19th century mathematicians were able to demonstrate that other forms of geometries different from Euclidian geometry could be developed. While these forms of geometry are different from Euclidean geometry, they are as consistent and valid as Euclidean geometry. These geometries are called non-Euclidean geometries. Two prominent forms of non-Euclidean geometries that were developed in the 19th century were Hyperbolic Geometry and Elliptic Geometry. The concept of hyperbolic geometry was first proposed by the Russian mathematician Nikola Ivanovich Lobachevsky (1793-1856) in 1829. It was independently developed by the Hungarian mathematician Janos Bolyai (1802-1860). The great German mathematician Karl Friedrich Gauss (1777-1855) had developed the concept of hyperbolic geometry even before Lobachevsky and Bolyai but he did not want to publish his results in his lifetime. Gauss's results were finally published 30 years after the works of Lobachevsky and Bolyai were published. The mathematicians who had earlier not paid much attention to the new form of geometry proposed by Lobachevsky and Bolyai started taking note of it after the publication of Gauss's results because of his eminence. Thus the publication of Gauss' results on hyperbolic geometry not only made the mathematicians appreciate the works of Lobachevsky and Bolyai but also opened the door to its further development. Hyperbolic geometry substituted the Euclidean parallel postulate by another postulate, which states: "Through a given point outside a given straight line pass more than one line not intersecting the given line." There are many theorems in hyperbolic geometry, which contradict the theorems of Euclidean geometry. For example, in Euclidean geometry the sum of angles of a plane triangle is always 180°, but it is not so in hyperbolic geometry. In hyperbolic geometry the sum of angles of a triangle is less than 180° and it would vary with the size of the triangle.

Nikola Ivanovich Lobachevsky

The concept of the elliptic geometry was first proposed by the German mathematician Georg Friedrich Bernhard Riemann (1826-1866) in 1854 in a paper entitled "Uber die Hypothesen, welche der Geometrie zu Grunde liegen" (On the Hypotheses which Form the Foundation of Geometry). The elliptic geometry rejected the Euclidean parallel postulate but on a different ground than adopted by hyperbolic geometry. In elliptic geometry, strictly speaking, there are no parallel lines; any two straight lines in a plane, if extended far enough, would eventually meet. Thus in elliptic geometry all lines perpendicular to a straight line meet at a point. Like in hyperbolic geometry, the sum of the angles is not equal to 180°, but unlike hyperbolic geometry the sum of angles in elliptic geometry is greater than 180°. The elliptic geometry is also known as Riemann geometry.

Janos Bolyai

The development of non-Euclidean geometries has in no way reduced the importance of Euclidean geometry. As Jan Gullberg says, "Euclidean geometry is still the basis of most practical applications of geometry – it has taken human beings to the Moon and beyond."

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(The article is a popular compilation of the important points on life and work of Euclid available in the existing literature. The idea is to inspire the younger generation to know more about Euclid and his work. The author has given the sources consulted for writing the article. However, the sources on the Internet are numerous and so they have not been individually listed. The author is grateful to all those authors whose works have contributed to writing this article.)

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Dwarfed – Still a Wanderer

the largest asteroid Ceres that lies within the Asteroid Belt (between Mars and Jupiter) and therefore has *not* cleared its neighborhood. It is here that Pluto lost out and we were left with a family of only eight planets!.

Astronomers at IAU defined two more categories of bodies orbiting the Sun – "Dwarf Planets" and "Small Solar System Bodies". A "dwarf planet" is a celestial body that is in orbit around the Sun, has sufficient mass for its self-gravity so that it assumes a nearly round shape, is not a satellite, but has *not* cleared the neighborhood around its orbit. With this definition, Pluto becomes a dwarf planet and is recognized as the prototype of a new category of trans-Neptunian objects. Eris and Ceres also become dwarf planets. Status of Charon and a few other Kuiper Belt objects still remains undecided. All other objects except satellites orbiting the Sun are referred to collectively as "small solar system bodies" and include all asteroids.

Many people, including several astronomers, did not take kindly to the demotion of Pluto. Many reacted more than sentimentally. Already efforts are afoot for the reinstatement of Pluto as a full planet. It is necessary to appreciate that science cannot be dogmatic and hence, any accepted theory or hypothesis is always open to scrutiny. With new information coming in, along with verification and validation of observations, we may be forced to change the way we perceive nature and change the age-old beliefs. If not, miracles like the sea water turning sweet and idols of gods drinking milk may continue to occur periodically! We cannot afford to get carried away by the age-old or traditional beliefs; rather we need to muster courage to accept the newly found facts. But for this to happen, it is imperative to have an open and an analytical mind. Indeed, this is how science has advanced through the centuries and continues to advance today. The reclassification has not in any way changed the information we have about Pluto. It has, however, changed our perception about Pluto as a planet.

Even though Pluto's categorization has changed, its fascination remains. The world's first spacecraft to Pluto, NASA's *New Horizons*, left Earth on 19 January 2006 on a nine-year voyage. It may even be subsequently dispatched to study a few other objects in the Kuiper Belt. Pluto and the Kuiper Belt are known to be heavily endowed with organic molecules and water ice – the raw materials out of which life evolves. *New Horizons* will explore the composition of this material on the surfaces of Pluto, Charon and Kuiper Belt Objects. Pluto may have been dwarfed, but it continues to be a wanderer. On 07 September 2006, Pluto was assigned the asteroid number 134340.

You can read more about Pluto in the article "Why poor Pluto is no longer a planet" by Dr. T. V. Venkateswaran in this issue of *Dream 2047*.

❐ **V. B. Kamble**

Why Poor Pluto Is No Longer a Planet

❑ T V Venkateswaran
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It is just about 75 years since the discovery of Pluto; hitherto cute little baby planet of our Solar System. With the raising of quite a few yellow cards in Prague, on 24 August 2006, by 3,000 and odd astronomers, Pluto was demoted from full-fledged planet to "dwarf planet." Moreover, under the revised classification, the object 2003 UB313, named Eris which in many ways precipitated this final debate, and much touted as the "10th planet", becomes the largest known dwarf planet. Indeed it is an irony that Pluto was a 'planet' when the *New Horizon* space mission was launched in January 2006; but will no longer be: as it would reach Pluto-Charon in 2015.

Not the first time

Demotion of stellar bodies from the initial status assigned to it is not new to astronomy; or for that matter science. In fact when Galileo Galilie famously turned his

IAU vote to demote Pluto

telescope towards the heaven he was blessed with the enchanting sight of rings of Saturn, mountains on the Moon-landscape and extraordinary sight of 'stars' rotating about the planet Jupiter. Yes, indeed Galileo unhesitatingly asserted that "that there are three stars in the heavens moving about Jupiter, as Venus and Mercury around the Sun" and named them initially "Medicean stars", in honour of Medic family who provided patronage to him during his years of trial and tribulations. However, they were subsequently reclassified as "Medicean planets"; for the naming them, as 'stars' were deemed inappropriate. In those days 'Moon' was the proper name for the natural satellite of Earth and many other satellites of planets such as Rhea of Saturn were also called 'planets'. It was only around 1700s that astronomers commenced the practice of calling the satellites of planets as 'moons'.

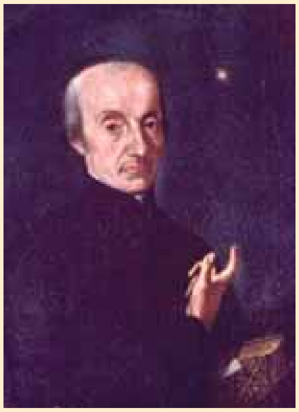
13 March 1781, William Herschel along with his sister Caroline discovered the planet Uranus. After careful study to rule out the possibility that this object could be comet, Herschel concluded that he has indeed discovered a 'new' planet; a planet about which no scared text had any inkling. Obviously such momentous discovery inspired many other astronomers to search the skies for other planets that may be lurking around.

Meanwhile, Johann Elert Bode, a German astronomer observed that, if you divide the distance from the Sun to Saturn into 100 lengths, then; Mercury is at 4 lengths; Venus is at 7 lengths (4+3); Earth is at 10 lengths (4+6); Mars is at 16 lengths (4+12). Nothing was seen at 28 lengths (4+24); Jupiter is at 52 lengths (4+48); Saturn is at 100 lengths (4+96). Discovery of Uranus too seemed to provide credence to this claim; as per the above rule the next planet beyond Saturn was to be at 196 (4+192); although Uranus was actually at 192 lengths. It was so near, it was thought to verify the law. Encouraged by this,

Ceres – largest asteriod

in 1800 Hungarian Baron, Franz Xaver von Zach, set up a group of astronomers called the Celestial Police, to find the 'missing planet' between Mars and Jupiter. They divided the Zodiac into zones and allocated different areas to different astronomers in the group.

But Lady Luck had a different plan; she smiled on Rev Father Giuseppe Piazzi, an Italian astronomer. Piazzi was compiling a star catalogue at Palermo Observatory in Sicily. He accidentally discovered a 'planet' between the orbits of Mars and Jupiter on 1 January 1801 and named it after Sicilian God of harvest 'Ceres'. Thus at the beginning of the 19th century there were 8 planets, including Ceres and Uranus. However Zach's Celestial Police was not in vain; Heinrich Olbers, a member of the Celestial Police discovered Pallas, which too was in the same orbital area of Ceres, on 28 March 1802. Karl Harding, another member of the Celestial Police, found Juno during September 1804. Heinrich Olbers discovered Vesta in March 1807. All these were classified as planets, and the number of planets rose to 11 including Vesta. However, there was something fishy in the discoveries; all these 'planets' seemed to occupy the same orbital area as that of Ceres.



Piazzi

Things appeared to cool off; the fifth planet in the same orbital area Astraea was discovered only in 1845, nearly 39 years after the discovery of Vesta. However, soon the floodgate of discovery of planets burst at its seam in 1847 with the discovery of three new asteroids. By the end of 1851 there were 15 asteroids, although astronomers were disquieted, they braved themselves and still listed all of them as planets – Solar System then consisted of 23 planets including Neptune (discovered in 1845), Uranus, and 15 'planets' in the orbital region of Ceres. By 1668 more than 100 stellar objects were discovered in that region. Surely things were becoming unseemly. In fact due to their star-like appearance, Herschel had declared even as early as 1802 that "from their asteroidal appearance, I shall take my name, and call them asteroids; reserving for myself, however, the liberty of changing that name, if another, more expressive of their nature should occur." Astronomers who had not heeded to this perceptive counsel at that time had to but agree; at one go 15 'planets' were reclassified as 'minor planets' or 'asteroids' around 1850s.

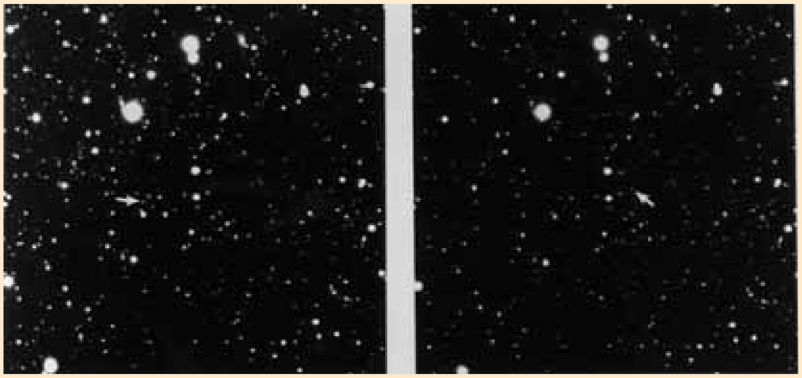
Discovery of Pluto

Discovery of Pluto is intimately linked to that of Neptune. Once Uranus was discovered astronomers observed that there was perturbations in its path; as if there were another massive body beyond Uranus giving it a jab. Convinced that there is a planet beyond Uranus search began; John Couch Adams in England and Urbain Levarrier in France spearheaded the search. They calculated the possible position of Neptune and with much drama the planet indeed was discovered by Johann Gottfried Galle and Heinrich Ludwig d'Arrest of Berlin Observatory on 23 September 1845.

Neptune did account for the observed perturbations in the path of Uranus; nonetheless Neptune itself showed perturbations as if being shoved around by a planet beyond it. 'Ah' said astronomers 'lets go for the Planet X', but it was soon evident to astronomers that treading the same path would not lead them to the Planet X. Calculations after calculations were made and yet the elusive planet was not to be seen. Where calculations and prediction failed; perseverance triumphed. With the invention of photography it was possible to record the position of stellar objects weeks apart and compare them. Clyde Tombaugh in fact did exactly that; and on 13 March 1930 Lowell Observatory announced the discovery of the ninth planet of the Solar System thereby bringing an end a search, which went on for about 25 years. When Tombaugh discovered Pluto astronomers welcomed it as the long sought "Planet X", which would account for residual perturbations in the orbit of Neptune. In a curious twist to the tale those perturbations proved to be illusory, and the discovery of Pluto was fortuitous.

Pluto an odd ball

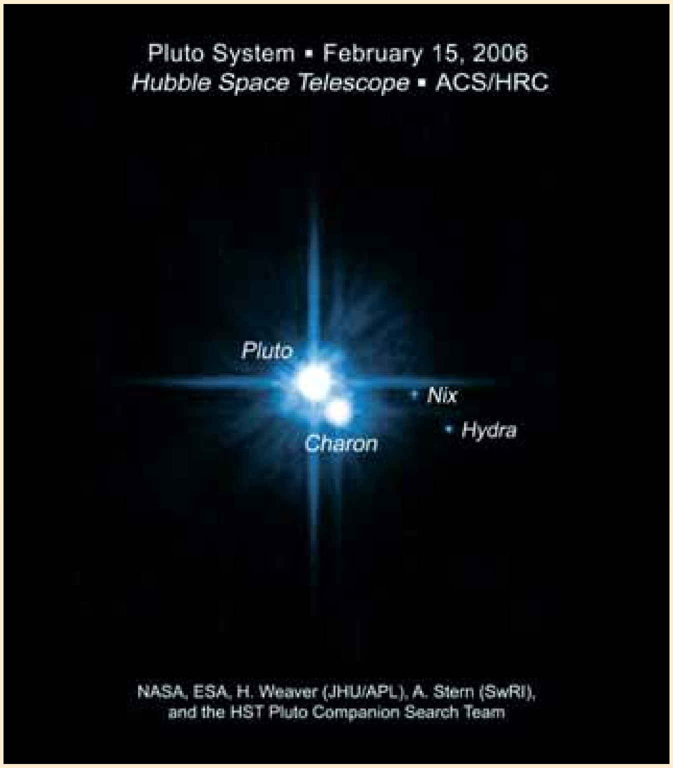
Right from the day of its discovery Pluto has been an odd ball. Pluto's orbit deviates significantly from a perfect circle while the major planets have quasi-circular orbits. It is so elongated that it crosses the orbit of Neptune. Due to this, from 1979 to 1999 for twenty years in fact Pluto was rather closer than Neptune. Pluto's orbit is also considerably tilted – whooping 17 degrees – compared to the orbits of the major planets. At the time of its discovery Pluto was estimated to be the size of Earth; later downgraded to size of Mars. Further, in 1978, Pluto's companion, Charon was discovered. Chaorn was estimated to be half its size; earlier the size of Pluto was estimated by including the size of Charon as it was not possible to resolve them separately. This led to further downsizing of Pluto; now we know that Pluto is much smaller than the major planets – just about 2,320 km across – smaller than seven moons of the Solar System including our Moon. Its mass is only 0.2% of the Earth's mass, and 100,000 times less than the mass of Jupiter. Pluto rotates in the opposite direction from most of the other planets. Pluto has been an irritant as a planet for astronomers quite long; astronomers were indeed puzzled what to make of this small, frigid world.



Pluto was discovered by comparing the photographs taken weeks apart

Why now?

2005 witnessed the 75th anniversary celebrations of the discovery of Pluto; Clyde Tombaugh was hailed. Nevertheless even before the din and dust settled down poor Pluto has been stripped of its planethood. As a matter of fact, even at an earlier occasion astronomers had suggested that Pluto does not really belong to the category



Pluto-Charon system with two moons

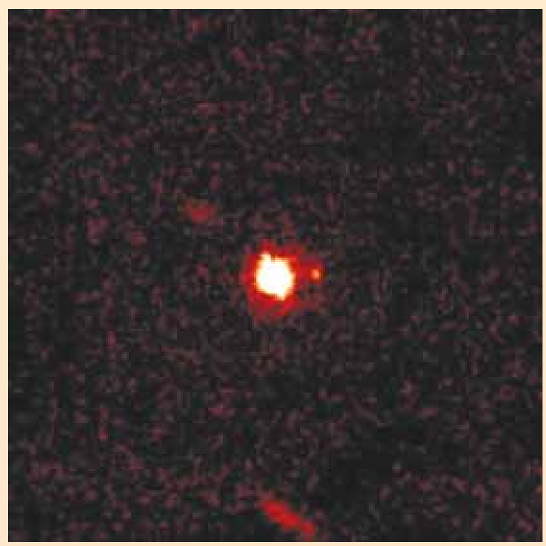
of planets. In 1999, an inadvertent suggestion, that Pluto may be termed the 10,000th minor planet giving it "dual citizenship" of sorts as both a major and a minor planet was made by Brian Marsden of the Minor Planet Center of IAU. This stormed into a major debate that spread into streets; passionate editorials were written and email campaign was conducted, in particular in USA, fearing that Pluto might be "demoted" to non-planet status. Taken aback, putting at rest the rumors, IAU had then emphatically declared that there were no plans to change Pluto's planetary status.

However, for astronomers it was evident for long that the fate of Pluto was sealed; sooner or later it would lose its status as Planet. The need for a strict definition was deemed necessary after new telescope technologies, especially Hubble Space Telescope and use of computer technologies to compare photographs, began to reveal far-off objects in the region of Pluto. The first Kuiper Belt Object (KBO) 1992 QB1 was discovered in 1992. 2001 KX76, an icy, reddish world over a thousand kilometres across was soon discovered. Two is a company, but surely three is a crowd; soon many more objects were discovered in the Kuiper Belt area going around the Sun in the region of Pluto. In 2002, Quaoar (1,280 km diameter) was discovered, making it a bit more than half the size of Pluto. Another discovery, Orcus, is probably even larger. In 2004, Sedna, an extremely distant object beyond the Kuiper Belt with estimated 1,800 km diameter close to Pluto's 2,320 km, was discovered.

As of now more than 783 objects have been discovered in the same region as that of Pluto. The proverbial last straw on the camel was the discovery of Trans-Neptunian object 2003 UB313 (named 136199 Eris). Announced on 29 July 2005, it rekindled the debate as to whether to classify Pluto as a planet or not. Eris is estimated to be at least as large as Pluto; and is the largest object yet discovered in the Solar System since Neptune in 1846, and has caused some to refer to it as the "10th planet" of the Solar System. It was clear that Pluto is embedded in a vast swarm of small bodies, just like the asteroid Ceres in the asteroid belt between Mars and Jupiter. Pluto has many friends orbiting nearby and at least one of them is larger than Pluto. There have been another important development in our knowledge of "planetary systems" in the last decade or so: the discovery of celestial bodies orbiting stars – exoplanets – other than the Sun. These recent developments make it pressing to arrive at a proper definition for the word "planet".

What is in a name?

In popular culture, whenever something new is discovered in the outer Solar System, the first question asked is "Is it bigger than Pluto?" When a newly discovered object is found to be only half the size of Pluto (2002 discovery of Quaoar) or maybe three-fourths



2003UB131 (popularly called as Xena)

the size of Pluto (2004 discovery of Sedna), there is a little disappointment and it is said that " Ok , well, it is not a planet". But when it is said "Well rather this one bigger than Pluto" (discovery of Eris or 2003 UB313) it is remarked "Hurrah! The 10th planet has been found!" In popular imagination only objects larger than Pluto are to be called planets. However, from the point of view of science it is arbitrary and whimsical. For the uninitiated, sure enough, the world of science appears to be weird. Bats are able to fly but they are not birds; whales waddle


The Hero (Dr Mike Brown who discovered Xena)

in ocean yet they are not fish but are mammals; penguins can swim and toddle but cannot fly, yet it is a bird! However, such classifications allude to deep relationships; penguins are closely related to birds from the point of view of evolution; and bats possesses organs specific to mammals. If Pluto is included as a planet, we have no physical basis for excluding Eris (2003 UB313), dozens of other large spherical KBOs, and Ceres. The term "planet" would then lose any taxonomic utility. But an important function of scientific nomenclature is to reflect natural relationships, not to obscure them.

IAU's resolution

International Astronomical Union (IAU), an international scientific body established in 1919, currently with 9,000 members, organizes once in three years a general assembly to take stock of the developments in astronomy. The XXVI General Assembly held in Prague Czech Republic from 14-25 August 2006 adopted a resolution giving the first-ever scientific definition to 'Planet' by a vote of the International Astronomical Union.

In the light of our improved understanding of the Solar System astronomers have revised their classification. An initial proposal put forward criteria that kept Pluto's status and brought the club to 12 – adding Eris, the asteroid Ceres, and Pluto's largest moon, Charon to the nine planets. But this scheme met with considerable opposition from astronomers at the assembly who felt that very soon many members of the KBOs could lay claim to membership of planetary club under this classification. Revised resolution that was adopted defines three distinct classes of objects in the solar system: planets, dwarf planets, and small solar-system bodies. There are eight planets in the Solar System: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. A dwarf planet is not a planet.

The resolution adopted states "A 'planet' is a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and (c) has cleared the neighbourhood around its orbit. Further it clarifies that "A 'dwarf planet' is a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, (c) has not cleared the neighbourhood around its orbit, and (d) is not a satellite. In addition the resolution states, "All other objects except satellites orbiting the Sun shall be referred to collectively as 'small Solar-System bodies'."

That a planet should go around the Sun is but natural, so is the second criteria, which essentially mean that the object should be massive enough to be crushed on its own weight into a spherical shape (or near spherical shape). This too is comprehensible; you do not want any and every lump of rock going around the Sun to be termed 'planet'. But how do we make sense of the third commandment?

The Third Commandment

The third norm is linked to the dynamics of planet formation. The Solar System includes several distinct populations; the planets, satellites, asteroid belt, Kuiper Belt, Oort Cloud, etc. These distinct populations reflect different pathways in the evolution of the solar nebula, which in the first place coalesced in to central star (Sun) and Solar System objects. In Safronov's model of planetesimals and planetary evolution, a planet is an end product of disk accretion around a primary star that sweeps up or scatters most of the mass from its orbital zone in the accretion disk around a central star. Further dynamics of planet formation is linked to the degree to which a body dominates the other masses that share its orbital zone. The disk evolution in a mature system tends to produce a small number of relatively large bodies (planets) in non-intersecting or resonant orbits, which prevent collisions between them. According to this model the inner region of the accretion disc coalesced into terrestrial planets; outer regions formed into gas giants. On the other hand objects like Ceres and Pluto remain in an arrested state of development, unlike mature planets and hence are rightly classified as 'dwarf planets'.


The 'zero' (Clyd Tombaugh, discovered Pluto)

Further in course the evolution of Solar System planets come to dominate their orbital region such that it is more massive than the total mass of all of the other bodies in a similar orbit. For example, the planet Neptune has 8,600 times the mass of Pluto, the largest body that crosses its orbit. Likewise, the planet Earth has 2 x 10^8 times the mass of the asteroid 1036 Ganymed, the largest body that crosses its orbit. The major planets have accumulated, captured, or ejected all the mass in their immediate proximity. They are the dominant bodies in their regions of space. In contrast, the asteroids and KBOs are members of populations with a shared orbital space, in which no member so dominates the others by mass. The two largest asteroids, Ceres and Pallas, differ in mass by a factor of about four and the largest known KBO (Eris 2003 UB313) has only about twice the mass of Pluto. Our Solar System has no intermediate cases between solitary bodies (planets) and members of populations, defined in this way.

Asteroids and comets, including KBOs, differ from planets in that they can collide with each other and with planets. It is postulated that about 3.8 billion years ago, after a period known as heavy bombardment, most of the planetesimals, which did not coalesce into planets within the Solar System had either been ejected from the Solar System entirely, into distant eccentric orbits such as the Oort cloud, or had collided with larger objects due to the regular gravitational nudges from the Jovian planets. Debris leftover from this evolutionary phase of solar system remains as asteroid belt, the Kuiper Belt, and the Oort cloud. Moons such as Phobos, Deimos,

Schematic diagram of evolution planetesimals, planets from primordial solar nebula.

Triton, and many of the small high-inclination moons of the Jovian planets are considered to be 'captured' planetesimals.

Moreover Neptune totally dominates Pluto's region of the Kuiper belt. While much of the material in the Kuiper belt has indeed been tossed aside or accumulated by Neptune, a very special region has actually been captured by Neptune. We now know that Neptune formed much closer to the Sun than where it was today, and, as Neptune moved out, it pushed objects in this special region out with it while forcing them into a peculation orbit where they orbit the Sun precisely twice for every three orbits of Neptune. Pluto is the largest of this class, and it and the others only exist where they do because of the dominance of Neptune. The same is the case with so called 'Trojan asteroids' of Jupiter, they are swept by Jupiter's gravity to remain 60 degrees ahead or 60 degrees behind the planet, in what are known as the 'Lagrange points'.

In fact in the light of our modern understanding, the conventional list of "nine planets"— four terrestrial planets, four giant planets, and Pluto – has lost any scientific rationale, and is now merely historical. While it is quite understandable that in 1930 astronomers felt that Pluto was an exceptional object and decided to call it a planet, majority of astronomers today recognize

Victor Safronov model of how planets evolved

The model proposed by Victor Safronov (1917-1999), Soviet astronomer, for evolution of planets around a star from an initial interstellar cloud makes our modern understanding of the dynamics of planet formation better. His theory was in contrast to the then prevailing theory that planets were the end product of a process of gravitational fragmentation of the proto-planetary disc. Safronov theorized that planets form from aggregation of countless smaller bodies: dust grains and debris left over in the Solar System after formation of the Sun. Initially the dust or small grains move about due to Brownian motion, or turbulent motions in the gas to cause the collisions that can lead to coalescing. However, when the bodies reach size of approximately one kilometre, then they can attract each other directly through their mutual gravity, aiding further growth into moon-sized protoplanets. Many such planetesimals are indeed formed in the accretion disc, many eventually break apart during violent collisions, but a few of the largest planetesimals survive such encounters and continue to grow into protoplanets and later planets. In this model planets are end products of secondary accretion in a disk around a primary star. Planets in this sense occur only in highly evolved (old) systems, which have reached the final cleanup phase of accretion, with the major bodies in stable non-intersecting orbits. In this model planets are the solitary bodies that prevail in the creative-destructive evolution of a disk, and are dynamically distinct from the populations of leftover debris – mainly asteroids and comets.

Pluto only as a large member of a vast population of small bodies beyond Neptune, and hence IAU has placed Pluto in the minor planet list and has renamed it as '134340 Pluto'.

Science is all about recognizing that earlier ideas may have been wrong. For a long time biologists thought that all microbes were germs causing diseases in humans. Today we are more enlightened we are aware that some bacteria are beneficial; moreover we have realized that there is another class of microbes called viruses. Sure enough we have changed our ideas about which bug was what. We are all better off now as the new classification has clarified meaning and has allowed researchers and health professionals go about their jobs better. It is no wonder that replying to a question as to how Clyde Tombaugh would feel about the Pluto's demotion, his wife Patricia Tombaugh stated, "He was a scientist. He would understand they had a real problem when they start finding several of these things flying around the place"

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Exclusive Food Recipes for Special People

❑ Dr. Yatish Agarwal
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"Eat not for material pleasure; eat to live."
Tirathankar Mahavir Quoted in Uttara adhyan

Some diseases have a close relationship with diet. Due to the way they are caused, some foods may play a role in their causation or cause them to worsen. Several old systems of medicine, especially ayurveda, have profound tenets on this food-disease connection, but those concepts rely more on philosophical thought, rather than firm scientific facts. In comparison, modern day biochemists, nutritionists and physicians make recommendations on definite biochemical basis.

Presented below is some sensible nutritional advice that may come useful to you, a friend or family member. If somebody in the family has had kidney stones, suffers from hyperacidity or ulcers, has recurrent migraine attacks, or suffers from intolerance to milk or wheat, these are lists you could hang on your kitchen door!

Cutting down the risk of kidney stones

People who have had a stone in the kidney run a high risk to develop it again. They can cut down the hazard in two ways: one, by keeping themselves well-hydrated by drinking plenty of water, and two, by cutting back on foods that contribute to the formation of stones.

A common culprit in formation of kidney stones is oxalate. Thus, if you have had a urinary stone in the past, a low-oxalate diet makes good sense.

The following foods have high oxalate content and are best restricted:

- Black gram
- Spinach
- Amaranth
- Mustard green
- Curry leaves
- Drumstick leaves
- *Gogu* (*pitwa or ambadi*)
- Lotus stem
- Almonds
- Cashew nuts
- *Amla*
- *Phalsa*
- Strawberries
- Plums
- Rhubarb
- Red chilli
- Chocolate
- Cocoa
- Tea

Keeping ulcers and hyperacidity in check

People who suffer from a gastric or duodenal ulcer, hyperacidity and/or acid reflux can significantly benefit by avoiding certain foods. The logic is straight and simple: foods that irritate the inner lining of the stomach are best restricted. The following foods make it to the 'avoidable' list:

- Red and black pepper
- Chilli powder
- Coffee, including decaffeinated coffee
- Tea
- Cocoa
- Cola drinks
- Alcohol

If the problem is that of acid reflux, try and restrict foods that upset the natural physiological valve that's situated between the exit point of food pipe and the mouth of the stomach. Foods that trip the gastro-oesophageal valve (sphincter) include:

- Tomatoes
- Citrus fruits and juices
- Chocolate
- Coffee
- Peppermint
- Fatty foods

If it is a question of reflux, it also pays to change the eating pattern. Do not eat big meals; rather, learn to enjoy small meals taken at frequent intervals.

Identify the head-busters

Some foods and beverages can also initiate a splitting headache. The attack occurs due to vascular disturbance initiated by one or the other chemical constituent in the food. The best prevention lies in identifying the possible head-busters and shying away from them.

The common culprits include:

- Chinese cuisine (with monosodium glutamate [MSG])
- Oranges
- Ripe bananas
- Vinegar
- Yeast
- Processed cheese
- Chocolate

- Tinned foods (which contain sodium nitrite/nitrates)
- Red meat
- Sherry
- Red wine

If milk is a problem…

Lactose is the milk sugar. If your intestines are short on lactase, the special enzyme that's crucial for its digestion, you had better switch to another good substitute. You may find this hard to digest, but in this country of doodh ki nadiyan, some 50 per cent people are deficient in lactase. If they ingest milk or any other dairy food, they suffer abdominal discomfort, bloating, flatulence, and diarrhoea.

If you also face these problems, it's best to go on a lactose-free diet and take supplemental calcium. Many foods besides milk contain lactose. The avoidable foods are:

- All milk products except yoghurt
- Cheese
- Commercial bread and dessert mixes
- Cream biscuits
- Milk chocolate
- Chewing gum
- Creamed and dehydrated soups
- Creamed, breaded, buttered vegetables
- Commercial creamed and breaded meats
- Foods with these ingredients: Milk, milk solids, dry milk, whey solids, and lactose

You may still take soymilk, tofu and yoghurt. Yoghurt does not generally cause problems in lactase-deficient people since it is set free of lactose by lactobacillus bacteria.

If you have the wheat allergy…

Celiac disease is a malady of the small intestine marked by intolerance towards gluten, a protein found in wheat, barley, and rye. In this condition, the lining of the small intestine gets inflamed and its absorptive villi shrink and disappear. Once that happens, the intestines cannot absorb the vitamins, minerals and other nutrients from the food. Over time, this leads to a variety of symptoms: fatigue, abdominal pain, intermittent diarrhoea, bloating and excessive passing of gas.

The treatment lies in a total change of diet. Foods that contain gluten must be strictly avoided. The inventory includes all foods or food ingredients made from commonly used grains, wheat, barley, rye, and oats. The foods to be completely avoided include:

- Wheat flour
- White flour (*maida*)
- Wheat bran
- Wheat germ
- Wheat starch
- Barley
- Rye
- Breads
- Cereals
- Biscuits
- Cakes
- Pies
- Gravies
- Sauces
- Pasta
- Flour or cereal products
- Vegetable protein
- Malt or malt flavouring
- Vegetable gum
- Oat gum
- Vinegar
- Condiments containing distilled vinegar
- Soy sauce or soy sauce solids
- Natural flavourings
- Caramel colouring
- Brown rice syrup
- Vanilla
- Alcohol

Sometimes you may find gluten in objects that you would never expect. For example, even if you were to use a knife for spreading butter that has breadcrumbs on it or eat deep-fried foods that are cooked in the same oil used for gluten containing foods, you could be in trouble. Lipstick, postage stamps, and medications that use gluten in a pill or tablet can also contain gluten. The next time that you wet the stamp with your tongue, watch out.

What can you eat?

The list of gluten-containing foods is so long, that you may be wandering what foods would be safe to eat. If you look around, it is actually not that bad. You could very well enjoy eating rice, legumes, dairy products, vegetables, potatoes, fruits and plain meats.

(Some more prescription diets next month!)

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Earthquake Tip 4

Where are the Seismic Zones in India?

Basic Geography and Tectonic Features

India lies at the northwestern end of the 'Indo-Australian Plate', which encompasses India, Australia, a major portion of the Indian Ocean and other smaller countries. This plate is colliding against the huge 'Eurasian Plate' (Figure 1) and going under the Eurasian Plate; this process of one tectonic plate getting under another is called 'subduction'. A sea, Tethys, separated these plates before they collided. Part of the lithosphere, the Earth's Crust, is covered by oceans and the rest by the continents. The former can undergo subduction at great depths when it converges against another plate, but the latter is buoyant and so tends to remain close to the surface. When continents converge, large amounts of shortening and thickening takes place, like at the Himalayas and the Tibet.

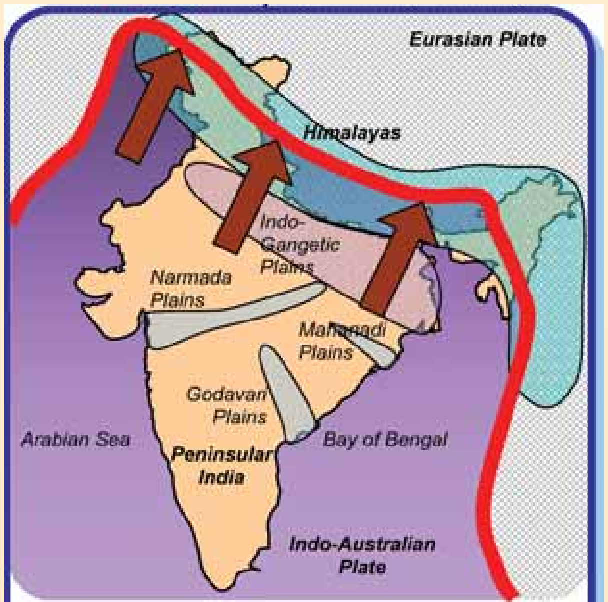

Figure 1: Geographical Layout and Tectonic Plate Boundaries at India

Three chief tectonic sub-regions of India are the mighty Himalayas along the north, the plains of the Ganges and other rivers, and the peninsula. The Himalayas consist primarily of sediments accumulated over long geological time in the Tethys. The Indo-Gangetic basin with deep alluvium is a great depression caused by the load of the Himalayas on the continent. The peninsular part of the country consists of ancient rocks deformed in the past Himalayan-like collisions. Erosion has exposed the roots of the old mountains and removed most of the topography. The rocks are very hard, but are softened by weathering near the surface. Before the Himalayan collision, several tens of millions of years ago, lava flowed across the central part of peninsular India leaving layers of basalt rock. Coastal areas like Kachchh show marine deposits testifying to submergence under the sea millions of years ago.

Prominent Past Earthquakes in India

A number of significant earthquakes has occurred in and around India over the past century (Figure 2). Some of these occurred in populated and urbanized areas and hence caused great damage. Many went unnoticed, as they occurred deep under the Earth's surface or in relatively uninhabited places. Some of the damaging and recent earthquakes are listed in Table 1. Most earthquakes occur along the Himalayan plate boundary (these are 'inter-plate' earthquakes), but a number of earthquakes have also occurred in the peninsular region (these are 'intra-plate' earthquakes).

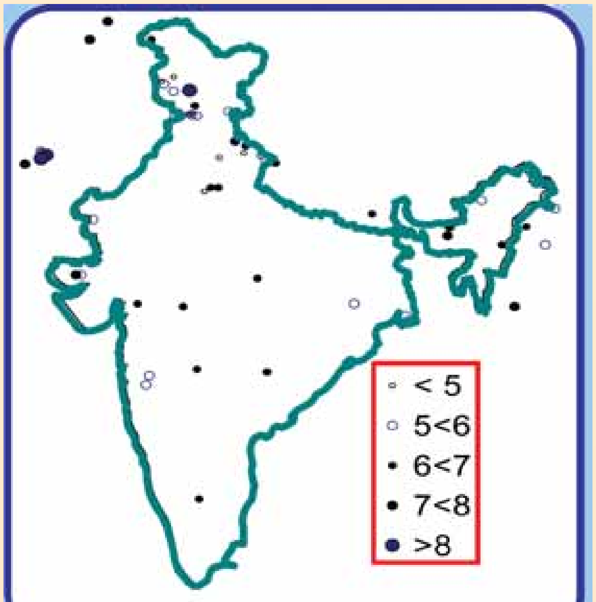

Figure 2: Some Past Earthquakes

Four great earthquakes (M > 8) occurred in a span of 53 years from 1897 to 1950; the January 2001 Bhuj earthquake (M 7.7) is almost as large. Each of these caused disasters, but also allowed us to learn about earthquakes and to advance earthquake engineering. For instance, the 1819 Kachehh Earthquake produced an unprecedented ~3m high uplift of the ground over 100km (called 'Allah Bund'). The 1897 Assam Earthquake caused severe damage up to 500km radial distances; the type of damage sustained led to improvements in the intensity scale from I-X to I-XII. Extensive liquefaction of the ground took place over a length of 300km (called the 'Slump Belt') during the 1934 Bihar-Nepal earthquake in which many structures were razed.

Table 1: Some Past Earthquakes in India

Date	Event	Time	Magni-tude	Max. Inten-sity	Deaths
16 June 1819	Kachchh	11:00	8.3	VIII	1,500
12 June 1897	Assam	17:11	8.7	XII	1,500
8 Feb. 1900	Coimbatore	03:11	6.0	X	Nil
4 Apr. 1905	Kangra	06:20	8.6	X	19,000
15 Jan. 1934	Bihar-Nepal	14:13	8.4	X	11,000
31 May 1935	Quetta	03:03	7.6	X	30,000
15 Aug. 1950	Assam	19:31	8.5	X	1,530
21 Jul. 1956	Anjar	21:02	7.0	IX	115
10 Dec. 1967	Koyna	04:30	6.5	VIII	200
23 Mar. 1970	Bharuch	20:56	5.4	VII	30
21 Aug. 1988	Bihar-Nepal	04:39	6.6	IX	1,004
20 Oct. 1991	Uttarkashi	02:53	6.6	IX	768
30 Sep. 1993	Killari (Latur)	03:53	6.4	IX	7,928
22 May 1997	Jabalpur	04:22	6.0	VIII	38
29 Mar. 1999	Chamoli	12:35	6.6	VIII	63
26 Jan. 2001	Bhuj	08:46	7.7	X	13,805

The timing of the earthquake during the day and during the year critically determines the number of casualties. Casualties are expected to be high for earthquakes that strike during cold winter nights, when most of the population is indoors.

Seismic Zones of India

The varying geology at different locations in the country implies that the likelihood of damaging earthquakes taking place at different locations is different. Thus, a seismic zone map is required to identify these regions. Based on the levels of intensities sustained during damaging past earthquakes, the 1970 version of the zone map subdivided India into five zones – I, II, III, IV and V (Figure 3). The maximum Modified Mercalli (MM) intensity of seismic shaking expected in these zones were 'V or less', VI, VII, VIII, and 'IX and higher', respectively. Parts of Himalayan boundary in the north and northeast, and the Kachchh area in the west were classified as zone V.

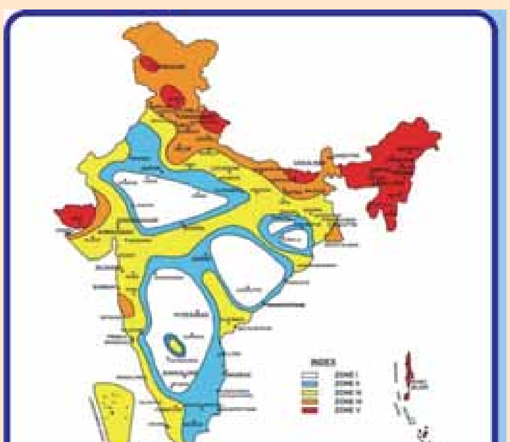

Figure 3: Indian Seismic Zone Map of 1970

The seismic zone maps are revised from time to time as more understanding is gained on the geology, the seismotectonics and the seismic activity in the country. The Indian Standards provided the first seismic zone map in 1962, which was later revised in 1967 and again in 1970. The map has been revised again in 2002 (Figure 4), and it now has only four seismic zones – II, III, IV and V. The areas falling in seismic zone I in the 1970 version of the map are merged with those of seismic zone II. Also, the seismic zone map in the peninsular region has been modified. Chennai now comes in seismic zone III as against in zone II in the 1970 version of the map. This 2002 seismic zone map is not the final word on the seismic hazard of the country, and hence there can be no sense of complacency in this regard.

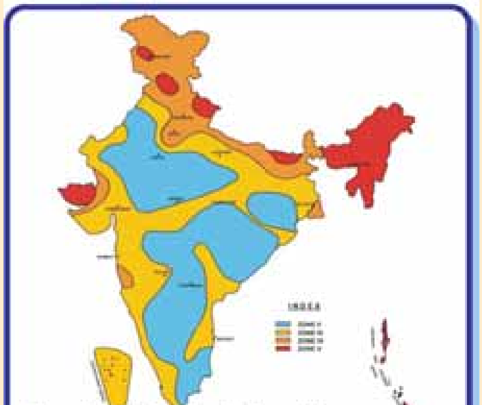

Figure 4: Indian Seismic Zone Map as per IS:1893 (Part 1)-2002

The national Seismic Zone Map presents a large-scale view of the seismic zones in the country. Local variations in soil type and geology cannot be represented at that scale. Therefore, for important projects, such as a major dam or a nuclear power plant, the seismic hazard is evaluated specifically for that site. Also, for the purposes of urban planning, metropolitan areas are microzoned. Seismic microzonation accounts for local variations in geology, local soil profile, etc.

Resource Material

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2. Dasgupta,S., et al, (2000), *Seismotectonic Atlas of Indian and its Environs,* Geological Survey of India.
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Recent Developments in Science and Technology

SMART-1 crashes on the Moon

European Space Agency's *SMART-1* spacecraft crashed on the Moon on 3 September 2006 after completing its mission. It crashed close to the planned landing site – a volcanic plain called "Lake of Excellence", producing a brilliant infrared flash that was observed by astronomers at the 3.6-metre Canada-France-Hawaii Telescope (CFHT) on Mauna Kea, Hawaii. The spacecraft hit the Moon at about 7,200 kilometres per hour and should have gouged out a crater 5-10 metres wide. Scientists hope the impact observations will reveal the chemical make-up of the rock and dust ejected by the impact. The data sent back by *SMART-1* are expected to throw light on the theory that the Moon was formed following the violent collision of a smaller planet with Earth, 4,500 million years ago. Before crashing, *SMART-1* completed more than 2,000 orbits of the Moon and mapped the mineralogy of the lunar surface. It also looked at the darker parts of the Moon's south pole for the first time. One of its most important discoveries was a "Peak of Eternal Light," an eerie mountaintop that is permanently bathed in sunlight, while all around are dark craters never touched by the Sun. These craters are believed to harbour water ice in the lunar soil. *SMART-1* data would help scientists to confirm if ice is present at the lunar poles, where the temperature never rises above –170°C. Any water on the lunar surface would be very helpful in the creation of permanent bases on the Moon.

SMART-1 was a small spacecraft, measuring only about one metre across and weighing 287 kg, and the first spacecraft using a solar-electric propulsion system (ion engine). It was also the first European spacecraft to go to the Moon. The spacecraft was launched on 27 September 2003 along with India's *INSAT-3E* by an Ariane-5 rocket from the Guiana Space Centre at Kourou in French Guiana. It was a part of ESA's "Small Missions for Advanced Research in Technology" (SMART), which are designed to test new spacecraft technologies. The primary objective of *SMART-1* was to test the solar-powered ion thrusters and several miniaturized scientific instruments, which are thought to be more efficient. *SMART-1* data would show how well they worked and if these technologies would be useful on future ESA missions.

Evidence of Dark Matter Found

For decades, astronomers have inferred that unseen matter lurks within and between galaxies because the mass of the visible matter in the universe cannot account for observed gravitational effects. Long believed to exist in large quantities – up to 90 percent of the total mass of the universe – it enters into many theories of the origin of the universe and its present large-scale structure and into models of gravitation and other fundamental forces between particles. Numerous candidates for dark matter have been proposed over the years, but none had been confirmed so far. Now, new studies with the Chandra X-ray Observatory offers clear-cut evidence that dark matter really does infuse galactic clusters and demonstrates beyond a reasonable doubt that dark matter exists.

The evidence of the existence of dark matter came from images of the "bullet cluster" of galaxies called '1E0657-56', created by an energetic collision of smaller clusters. According to astronomers, it is the most explosively violent such merger ever observed. Chandra X-ray images of the cluster show clearly distinct areas of normal matter and dark matter, which shows up as a strong gravity field. Astronomers measured the cluster's gravitational influence by tracking its effect on the light from more distant "background" galaxies, a phenomenon known as gravitational lensing in which the positions of the distant galaxies appear to shift under influence of gravity. The results show a clear separation between the gas in the cluster, which is normal matter, and gravity, thereby showing the presence of dark matter.

Source: *Science*, 25 August 2006

New Age of Earth's Atmospheric Oxygen

Most geologists agree that Earth's atmosphere was oxygen-free until 2.4 billion years ago. This belief is based on the finding in ancient sedimentary rocks of the presence of a special kind of sulphur compounds with a certain sulphur-isotope ratio. The particular ratio of the sulphur isotopes in rocks older than 2.4 billion years indicates exposure to ultraviolet radiation, which would be possible only if there were no ozone layer, and hence no oxygen. The absence of ozone would have allowed ultraviolet radiation to penetrate deep into the atmosphere, where it could interact with sulphur dioxide emitted by volcanoes, forming new sulphur compounds with distinctive isotopic ratios. The isotopic data are robust, numerous and agree with the most common interpretation of the geological evidence and provide compelling testimony for an oxygen-free atmosphere before 2.4 billion years ago. It also implied that all sulphur-containing sedimentary rocks older than 2.4 billion years should show the same isotopic ratio whereas younger sulphur-containing rocks would have a different isotopic ratio.

Now, in a paper in *Nature* (24 August 2006) researchers Hiroshi Ohmoto of NASA Astrobiology Institute and Department of Geological Sciences, Pennsylvania State University, USA, and colleagues report data on sulphur isotopes in sedimentary rocks that seem to contradict the existing theory. Analysis of 3.43 billion-year-old sedimentary rocks collected from Western Australia and 3.227 billion-year-old sedimentary jasper beds in South Africa not only showed a different sulphur isotopic ratio, but also presence of oxidised rocks, indicating the presence of oxygen in the atmosphere much before 2.4 billion years, as was believed till now.

The history of atmospheric oxygen is crucial for understanding the origin and history of life, the evolution of the atmosphere and the peculiar nature of early sediments. The new finding may throw new light on the appearance of the life-sustaining gas in Earth's atmosphere.

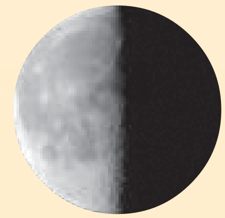
Source: *Nature*, 24 August 2006

Sky Map for October 2006

Full Moon

07 October

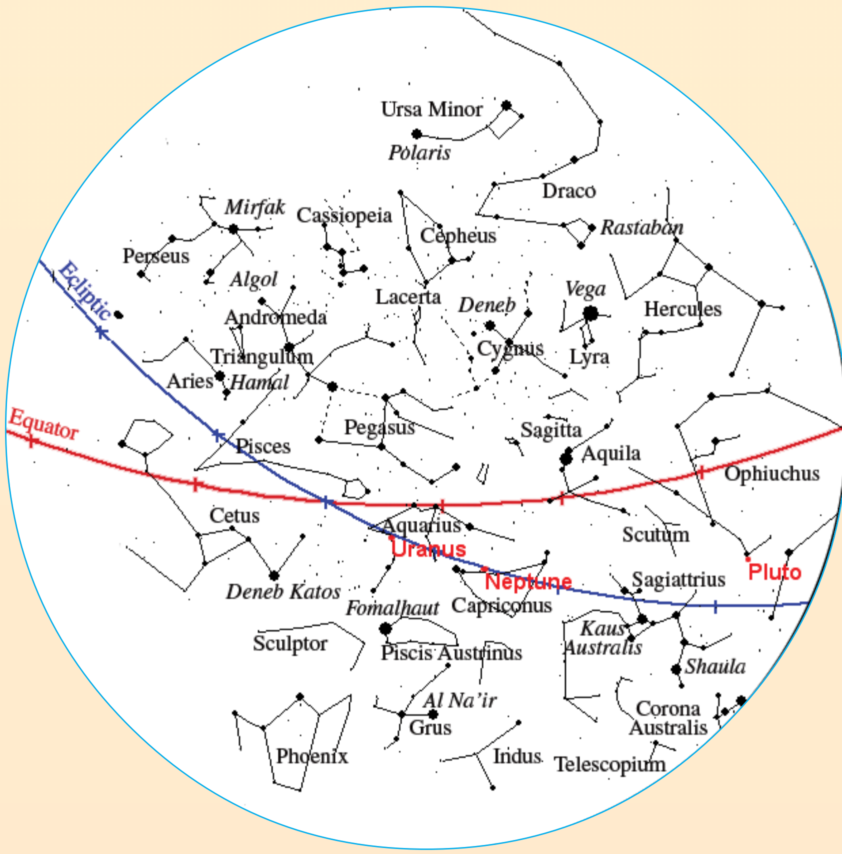
Moon - Last Quarter



14 October

North

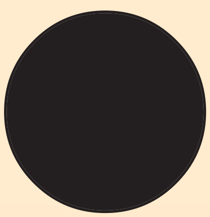
East



West

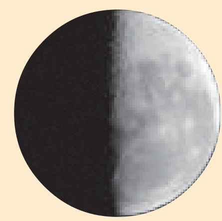
South

New Moon



22 October

Moon - First Quarter



30 October

The sky map is prepared for viewers in Nagpur (21.09° N, 79.09° E). It includes the bright constellations and planets. For viewers south of Nagpur, constellations of the southern sky will appear higher up in the sky, and those of the northern sky will appear nearer the northern horizon. Similarly, for viewers north of Nagpur, constellations of northern sky will appear higher up in the sky, and those of the southern sky will appear nearer the southern horizon. The map can be used at 10 PM on 1 October, at 9:00 PM on 15 October and at 8 PM on 30 October.

Tips for watching the night sky:

(1) Choose a place away from city lights/street lights. (2) Hold the sky-map overhead with 'North' in the direction of Polaris. (3) Use a pencil torch for reading the sky map. (4) Try to identify constellations as shown in the map one by one.

Planet and Dwarf Planet in the Solar System:

Uranus & Neptune: Not a naked sky object. Hence not visible.

Pluto: Not a naked eye object. Hence not visible.

Prominent Constellations: Given below are prominent constellations with brightest star therein (in the parenthesis). Also given are their Indian names in *italic*.

Eastern Sky : Perseus (Mirfak, Algol) / *Yayati*, Aries (Hamal) / *Mesha Rashi*, Cetus (Deneb Kaitos) / *Timingal*, Triangulum, Andromeda / *Devyani.*

Western Sky : Ophiuchus / *Bhujangdhari*, Hercules / *Shauri*, Sagittarius / *Dhanu Rashi*, Lyra (Vega)/*Swaramandal (Abhijeet)*, Scutum.

Southern Sky : Phoenix, Indus, Grus / *Bak*, Telescopium, Piscis Austriunus, Sculptor

Northern Sky : Ursa Minor (Polaris) / *Dhruvamatsya (Drhuvataraka)*, Cassiopeia / *Sharmista*, Lacerta, Cepheus /*Vrishaparv*, Draco/*Kaleey*.

Zenith : Pegasus / *Mahashav*, Cygnus (Deneb)/ *Hansa (Hansa)*, Aquarius / *Khumba Rashi*, Capriconus / *Makar Rashi*, Sagitta, Pisces, Aquila (Altair)/*Garuda (Sravan)*.

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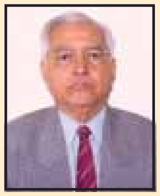
Obituary

B.S. Padmanabhan



B.S. Padmanabhan, a veteran journalist died on September 04, 2006. He was 80. Padmanabhan started his career as a Staff Reporter in The Hindu at Chennai in the late 1940s. From 1961 till retirement in 1992, he was Special Correspondent to the Hindu in New Delhi. After retirement, he had been working as a Freelance Journalist based in Delhi.

During his career, he evinced special interst in covering developments in the field of Science and Technology and contributed a number of informative and critical articles to The Hindu on Science Policy and functioning of scientific organizations, including CSIR, ICMR and ICAR. He was a major contributor to the series "Our Scientists" in The Hindu. This series of articles profiled various Indian scientists explaining their research work in a language easily understood by the lay readers. Even after his retirement he was active and was writing for various journals and newspapers.

Padmanabhan was a associated with Vigyan Prasar as a Fellow. He penned an important publication documenting the entire journey of "Vigyan Rail : Science Exhibition on Wheels", a unique project in the History of Science & Technology Communication undertaken by Vigyan Prasar. He also wrote a number of articles for "Dream-2047" . Even a few days before his death he had expressed his desire to write more articles for "Dream 2047".

Padmanabhan is survived by his wife and four sons.