

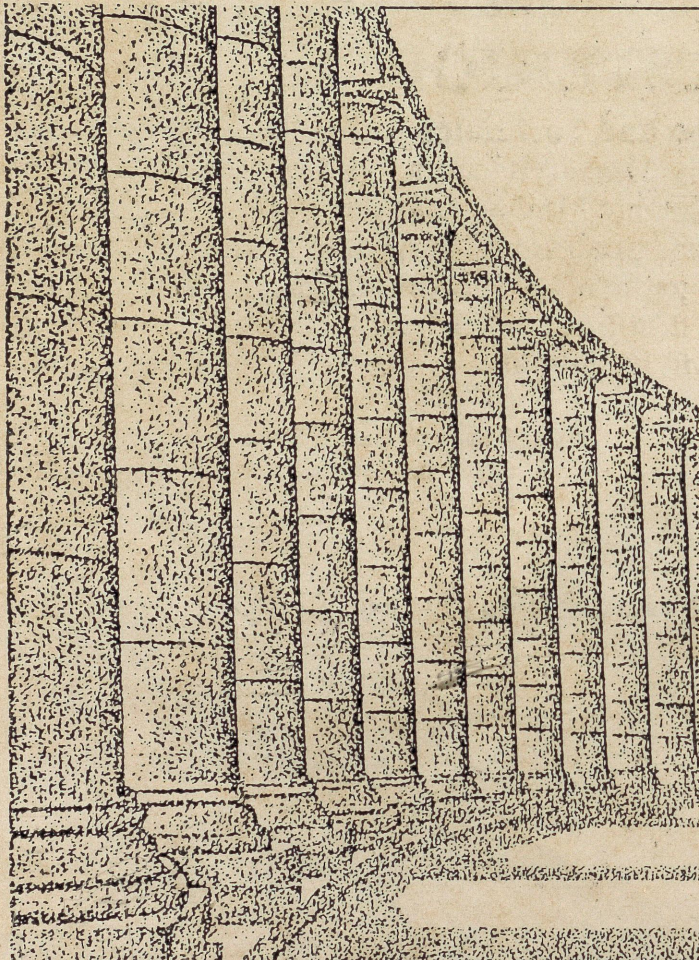
MARCH 1990

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SCIENCE REPORTER

SUPERNOVA!

ALSO:
FEATHERED MUSICIANS
THE HEADQUARTERS



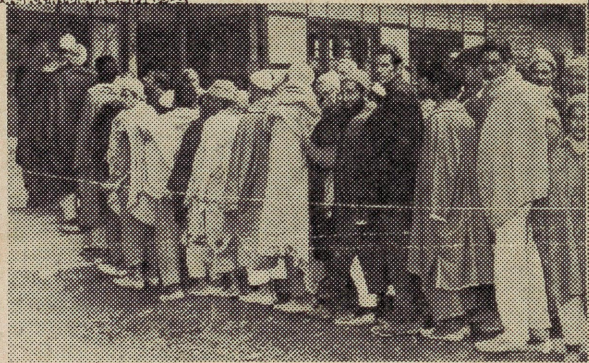
PILLARS OF FREEDOM

In the third week of November.
Our men and women,
young and old,
moved in millions
to exercise their right.

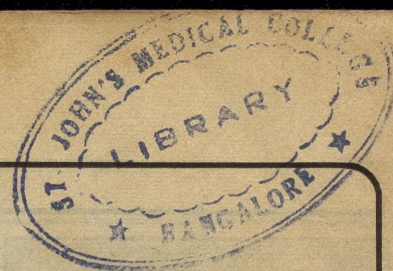
Unlike the winds of change
elsewhere, our transition was
democratic, smooth and swift.

The ninth General Elections to
Lok Sabha, once again
demonstrated to the world,
our strength derived from
our abiding faith in Freedom
and Democracy.

That Faith,
that Flame of Freedom.
We shall protect and preserve.



**Voice of the People
Voice of the Nation**



SERC School on "GEOMAGNETISM AND EARTH'S INTERIOR"

(Department of Science and Technology, Government of India)

The Science and Engineering Research Council (SERC) in the Department of Science and Technology has entrusted Indian Institute of Geomagnetism (IIG), Bombay to co-ordinate a five year programme of Annual Summer/Winter Schools to encourage research by younger scientists in the frontier areas of "Geomagnetism and Earth's Interior". The first Summer School in this series on Electromagnetic Induction in the Earth" will be held at:

Department of Earth Sciences

(Prof. Sri Niwas, Joint Director Summer School)

Kurukshetra University

Kurukshetra - 132 119 (Haryana)

From June 11 - June 30, 1990 and will cover the following topics:

- | | | |
|----|---|-------------|
| 1. | Geoelectromagnetism | 10 Lectures |
| 2. | Response Functions In Electromagnetism | 10 Lectures |
| 3. | Geomagnetic Depth Sounding | 10 Lectures |
| 4. | Magnetotellurics | 10 Lectures |
| 5. | Electromagnetic Modelling | 12 Lectures |
| 6. | Geoelectric Structure of Earth's Interior | 12 Lectures |

The Summer School will admit 40 participants on all India basis. Preference will be given to: (i) those working for Ph.D degree and fresh Ph.Ds. in Solid Earth Geophysics and Allied Fields in National Laboratories/ Universities and (ii) geoscientists working in organisations like ONGC/GSI, etc. Financial support to the extent of first class train fare and free boarding and lodging will be provided to participants.

Those interested in attending the School should write to:

Dr. B.R. Arora

(Director Summer School)

Indian Institute of Geomagnetism

Colaba, Bombay - 400 005

giving following informations:

Name and address for correspondence, academic qualifications, age, affiliation, field of research and list of publications, if any, together with a nomination letter from present employer.

Last date for the receipt of the required information is March 31, 1990. Information regarding selection will be sent by April 20, 1990.

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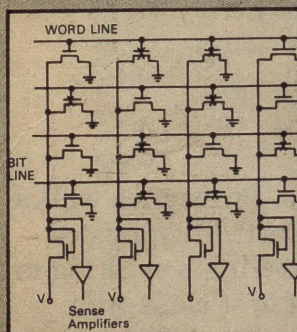
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SUPERNOVA!

AMALENDU BANDOPADHYAY

First observed in 1987, supernova 1987A is still a centre of attraction for astronomers. The author recounts the historical discovery and describes the wealth of information it has provided

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FEATHERED MUSICIANS

RAMACHANDRAN NAMBIAR

"There is more to a bird song than simply its melodious and musical quality" says the author. Today, bird songs are not only being analysed for their hidden avian implications but are also being recorded and mass-produced for joy listening

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SEMICONDUCTOR MEMORIES

MUKHTAR AHMED

All large computers have a main memory. Devices used as main memory are either magnetic cores or semiconductors. The latter provide low cost and small-sized memories

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National Institute of Immunology

P.S. SHANKAR

Besides a host of new achievements, NII scientists for the first time have succeeded in producing a calf by non-surgical transfer

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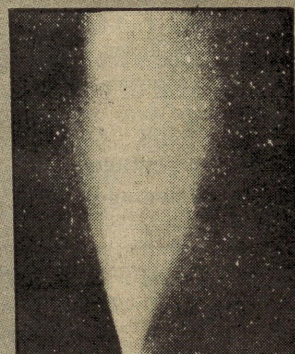
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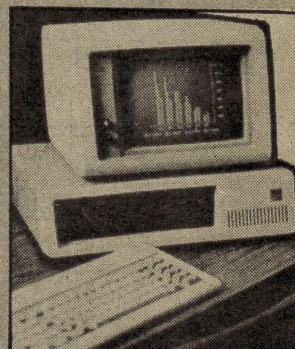
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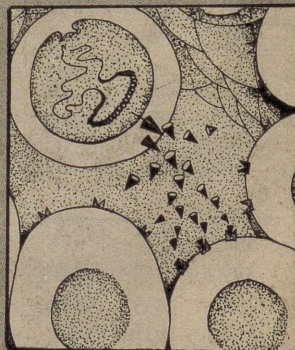
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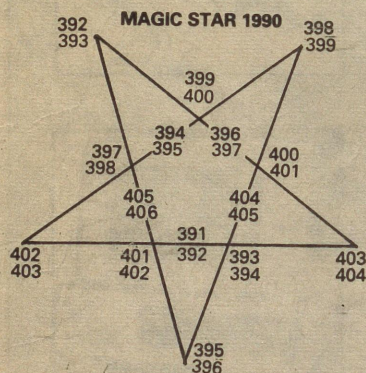
Magic Star 1990

Sir, Given here is a Magic star 1990 which uses numbers from 391 to 405 to make up a total of 1990.

1. Corners of star
2. Corners of pentagon
3. Centres of pentagon
4. In any line 4-8

Such an arrangement is possible once in 5 years. To convert this star to Magic star-1995, all you have to do is to change the numbers to one higher:

$$\begin{aligned}
 391 + 1 &= 392 & 399 + 1 &= 400 \\
 392 + 1 &= 393 & 400 + 1 &= 401 \\
 393 + 1 &= 394 & 401 + 1 &= 402 \\
 394 + 1 &= 395 & 402 + 1 &= 403 \\
 395 + 1 &= 396 & 403 + 1 &= 404 \\
 396 + 1 &= 397 & 404 + 1 &= 405 \\
 397 + 1 &= 398 & 405 + 1 &= 406 \\
 398 + 1 &= 399
 \end{aligned}$$



MAGIC STAR 1990			
1	2	3	4
398	399	396	398
403	400	404	399
395	393	391	394
402	401	405	397
392	397	394	402
1990	1990	1990	1990
5	6	7	8
402	392	392	398
401	399	397	400
391	396	405	404
393	400	401	393
403	403	395	395
1990	1990	1990	1990

This star was given to me by (Late) D.R. Kaprekar in 1985.

R.A. Altekar
Nashik 422 004

Hair

Sir, I must thank C.B. Sharma for his informative and educative article **Care—for long lustrous hair** (*S.R.*, January 1990). In the article, author has presented important and useful information regarding hair in a simple language. The author has pointed out that main body of hair is composed of dead cells but he has not paid much attention to it as well as on the causes of toughness of hair which is closely related to pH (i.e. H^+ ion concentration).

The outer layer of hair, nails and skin is made up mostly of 'keratin', dead cell material composed of the 20 different amino acids. Keratin, the fibrous protein has the polypeptide structure and according to Linus Pauling, the chains are regularly coiled to form a structure called the α -helix. The structure consists of a stretched-out chain of amino acid residues wound into a spiral which is held together by hydrogen-bonding between the carbonyl group of one amino acid and the amino group of an amino acid farther along the chain. Each amino acid residue is separated from the next residue by equal space, and the helix makes a complete turn for each 3.6 residues. The keratins of hair consist of bundles or cables of three or seven such α -helical coils twisted around each other.

The extent of toughness of hair, nails and skin is mainly due to ionic bonding between $-NH_3^+$ and $-COO^-$ ions on neighbouring chains and due to involvement of glutamic acid groups, the attraction is strongest at pH = 4.1. Anything that increases the pH of hair or skin above 4.1 makes it less tough by weakening the

ionic bonds (since there will be fewer $-NH_3^+$ cations). Since water brings the pH close to 7, wet hair can be stretched to 1.5 times its dry length and "moisturised" skin is soft and flexible.

P.C. Sinha
Patna

II

Sir, Thanks to C.B. Sharma for his valuable and educative article **Care—for long, lustrous hair** (*S.R.*, January 1990). This article inspires readers to know the scientific basis of the work done on hair. Sharma has explained the factors that effect the hair and also how to improve it.

I request you to publish more such articles on other parts of the body.

Dipanjali Devi
Vill. Adattari,
Assam 781126

Insulin and Blood Sugar

Sir, The article **The riddle of diabetes**, published in the September '89 issue of **Science Reporter**, was informative and praiseworthy. However, the role of insulin in reducing blood glucose level was not clearly discussed. I would like to add that in case of high concentration of glucose in blood, insulin is secreted at an increased rate, and the increased insulin level accelerates the entrance of blood glucose into liver and skeletal muscles. The hormone insulin further stimulates the synthesis of the enzyme, hexokinase, in liver which catalyses the phosphorylation of glucose to glucose-6-phosphate, which fails to diffuse into the blood and is further converted to glycogen, to be stored primarily in the liver.

Madhumita Basu
M.Sc. Ist Year
Biochemistry Department
Ballygunje Science College
Calcutta

REACTIONS

The Killer Drink

Sir, the above article (*S.R.* Dec. 1989) by K.C. Kanwar and others is informative and useful especially at this fag end of the century when epidemiological incidences of alcoholism are too disquieting. It would have been more interesting if the authors could mention chemically the reactions of ethanol with male and female endocrinal secretions, its subsequent oxidation and decomposition stagewise, from cardiovascular stage to CNS stage. Alcohol is also responsible for retarding the absorption of minerals such as calcium from the intestine. Its diuretic influence which causes rapid dehydration in the body needs special mention.

The author's downright rejection of alcohol as a major CNS depressant and a potent health hazard is a serious injustice to one of the world's oldest and most elegant drinks. Donald Norfolk in his famous book **Fare-well to Fatigue** has quoted the Scottish doctor Dr Francis Anstie as laying down the safety limits for drinkers as 1½ Oz of fluid alcohol per day. Furthermore, the medicinal values of liquor cannot be ruled out. But it can be said with certitude that the injuries caused by alcohol outweigh the goods it can ever deliver.

Hav. Abhiram Nanda
Bombay-400 005

Plant Kingdom

Sir, I have been reading *Science Reporter* for last two years. In each issue you have published some interesting topics. In this month (*S.R.* January 1990) your two articles, **Our Vanishing Plants** and **Pilgrimage to Kew** by Dr Jain and Dr Kak respectively, are of special mention. I must thank Dr Jain for giving knowledge about plants of ornamental, medicinal and scientific values. Plants of phytogeographic significance and of forestry importance have also been

described. He has also described beautiful plants of family *Orchidaceae* and *Nepenthaceae*. Dr Kak has given beneficial information about the flora of Kew gardens. I hope, you will publish such topics relating to plant kingdom in future as well.

Ashok Kumar Singh
Patna-6

Literate Superstitious

Sir, The article **Nehru and Scientific Temper** by Dr. H. Narasimiah (*S.R.*, November 1989), was interesting and threw new light on India's first Prime Minister.

I wish to differ with Dr. Narasimiah when he says that the present system of education is converting an uneducated, superstitious person into an educated superstitious person. I sincerely feel that it would have been more appropriate if he had used 'literate superstitious person' instead of "educated superstitious person".

K.V. Narendra
Bangalore-560 003

Archangel

Sir, I have been going through *Science Reporter* for the past several months and found the magazine very interesting and educative. Being a science graduate, I am virtually attached to it. Because of its magnetic effect, I must say, *Science Reporter* is the archangel—spreading message of the scientific knowledge among young intelligentsia of the country.

I feel the absence of science fiction in *S.R.* If the regular publication of science fiction is not possible, it may be published in alternative issue. Please also publish a full length article on the Kirlian-photography.

Yogesh Gupta
B.Sc. (Maths)
646, Azad Mahal, Sadar Bazar
Lucknow (UP) 206002

Astronomy

Sir, Thanks for publishing the article **The Last Planet** by Biman Basu (*S.R.*, October 1989) which gives valuable and interesting data about the eighth planet, Neptune, of our solar system.

Please publish more articles on astronomy and advancing technology used in astronomy.

Ashok Kumar Sahu
Burla-768 018, Orissa

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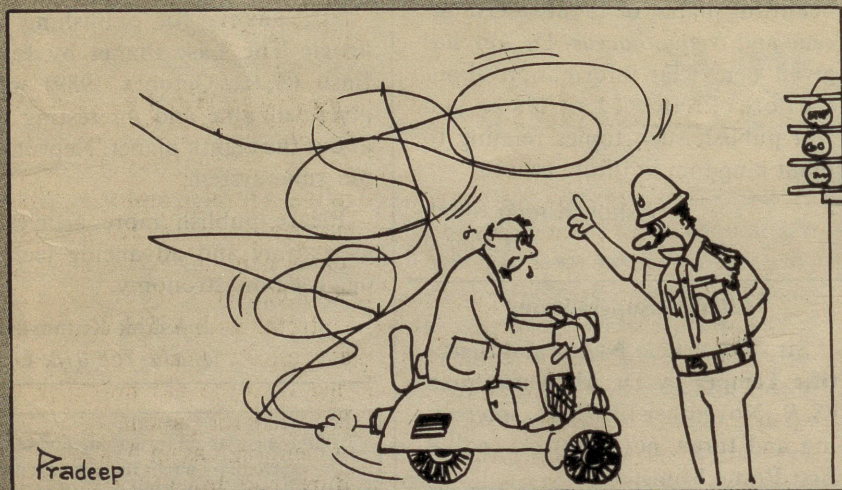
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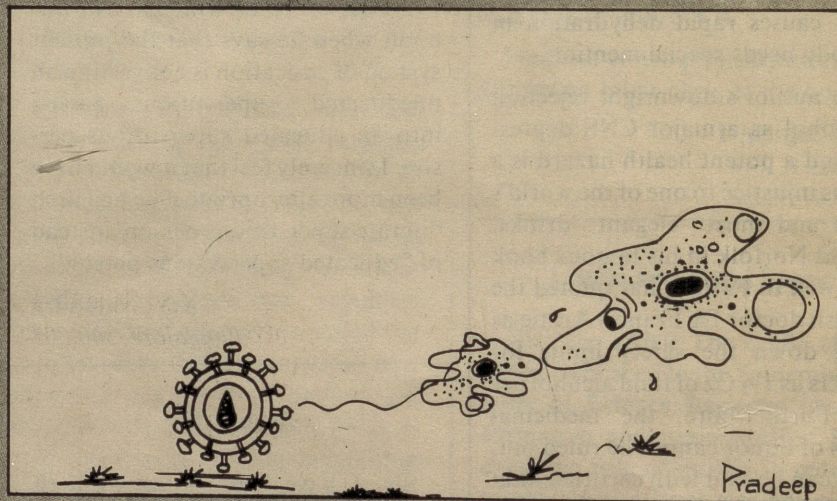
CARTOONS



Pradeep

"Remember this is a road, Prof. See ! You are a human being not a particle to follow Brownian movement".

"Oh my God! throw it immediately. This is not a ball to play with my son. It is AIDS virus, do you know?"



Pradeep

Infrared Spectra (IR) tells you about the presence of functional groups in a chemical compound.



Pradeep

"How I got the idea of this latest sweater design? One day I saw an 'I.R. spectra' in his papers. He is a scientist, you know!"

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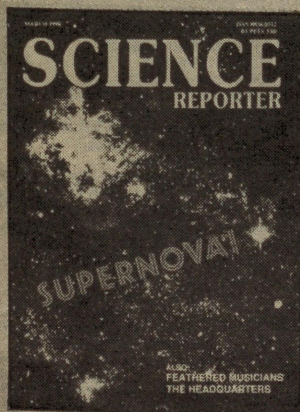
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On the edge of the huge cloud of glowing gas, the Tarantula nebula, is seen Supernova 1987 A (*middle right*) as it appeared on February 27, 1987 through the one-metre Schmidt telescope at the European Southern Observatory, Chile

Cover Design: K.B. Dhingra

Avoidable Complications

THE controversy over the recent death of a foreign diplomat of suspected AIDS and the subsequent happenings raise several crucial issues regarding risks to medical personnel handling AIDS cases. As reported in the press, the diplomat died of cancer of the stomach and was HIV seropositive, meaning he was infected with AIDS virus. Doctors attending on him are reported to have refused to carry out a surgery on him on the plea that the concerned Institute did not have the infrastructure to treat AIDS patients. But when the patient succumbed to his illness his death certificate did not mention it as an AIDS case. It is also reported that mandatory procedures laid down for handling of the dead body of an AIDS victim, such as wrapping it in double plastic bags, were not followed nor did it carry a tag stating clearly that the patient was an AIDS victim.

Despite these lapses the matter may not have attracted much attention had it not exposed a team of unsuspecting medical personnel to potential risk of AIDS infection. The medical team which embalmed the body in the anatomy department of another medical college is reported not to have taken even simple precautions like wearing gloves or face masks while handling the body. The guidelines issued in October 1989 by the Central Health Education Bureau of the Directorate General of Health Services clearly states that "gloves, goggles, face mask, cap, full plastic sleeve, plastic aprons and waterproof gumboots must be worn" while handling the dead body of HIV infected person.

That such a thing could happen despite there being clear guidelines for handling of bodies of AIDS victims underscores the unfounded fears about the disease that exists even in the medical profession. It would be naive to take the plea of inadequacies in the present guidelines as being the reason for not following them. True, there is need to update the guidelines on the basis of recent scientific advances in the field. Till that is done, the medical authorities must ensure, in public interest, that the present guidelines are strictly followed in all hospitals and medical institutions so that innocent persons are not exposed to unnecessary risks.

Looking ahead, there are developments in other areas such as biotechnology which demand great care in large scale application as they have potential social consequences. Techniques like amniocentesis, for example, can be misused for indiscriminate female foeticide unless their use is strictly restricted. But, again, mere guidelines, however comprehensive, cannot be a panacea unless it can be ensured that they are not violated. There is need for some kind of a regulatory body which could monitor adherence to all such guidelines and identify violators for prosecution. Only then could we ensure that the fruits of new scientific researches are not tainted by avoidable complications and risk to human life.

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SUPERNOVA!



WHAT is a supernova? When a star, usually quite faint, undergoes a sudden, tremendous increase in its radiative output, the scale of which is indicated by the description often applied to this peculiar type of variable star—"cataclysmic variables", the phenomenon is called a nova in astronomy. The increase in the apparent magnitude of a nova is usually of the order of ten magnitudes, indicating a ten-thousand-fold increase in actual luminosity. This increase takes place, in most cases, in a period of only 10-50 hours. It is rare for a nova to remain at maximum brightness for any length of time; usually they start to fade almost immediately, although at a much slower rate than the rise to maximum.

The term supernova was originally applied to that nova whose increase in absolute luminosity was very much greater than normal—the distinction being purely a quantitative one. It is now realized, however, that there are qualitative differences between a nova and a supernova. The supernova phenomenon was first distinguished from that of ordinary nova by Walter Baade and Fritz Zwicky in 1934. Supernova is extreme brightening of a star. The increase in magnitude is of the order of 15 or more.

When it was first observed in 1987, it created a sensation in the astronomical world. Three years later, supernova 1987A is still a centre of attraction for astronomers. **AMALENDU BANDO-PADHYAY** recounts the historical discovery and describes the wealth of information it has provided

In astronomy, magnitude is a concept which defines apparent brightness, of a star or other celestial bodies. The Greek astronomer Hipparchus selected about 20 of the brightest stars visible to the naked eye and called them first-magnitude stars. All those barely visible were designated as sixth-magnitude stars. The basic scale of magnitudes can be extended in both directions, stars one magnitude brighter than first magnitude have been designated as magnitude 0; still brighter ones magnitude -1, and so on. On this scale the magnitude of the Sun is -26.7 and the magnitude of the Full Moon is of the order of -14.

The bright explosion which marks



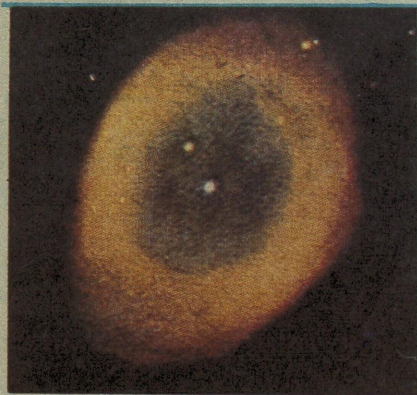
Tycho Brahe



Kepler

the death of a star is a supernova. Where no star was seen before, astronomers see a bright new star shining. When first recognized, such objects were named novae (pronounced 'no-vee') meaning new stars, although astronomers now understand that the star is not new but was previously too faint to be noticed. In 1935 it was formally understood that there were at least two very distinct kinds of nova, one much brighter than the other. The fainter kind is probably caused by a relatively weak explosion in one of a pair of stars orbiting each other. The brighter kind (which is 100,000 times brighter) is a supernova and it is this explosion which marks a stellar death.

COVER STORY



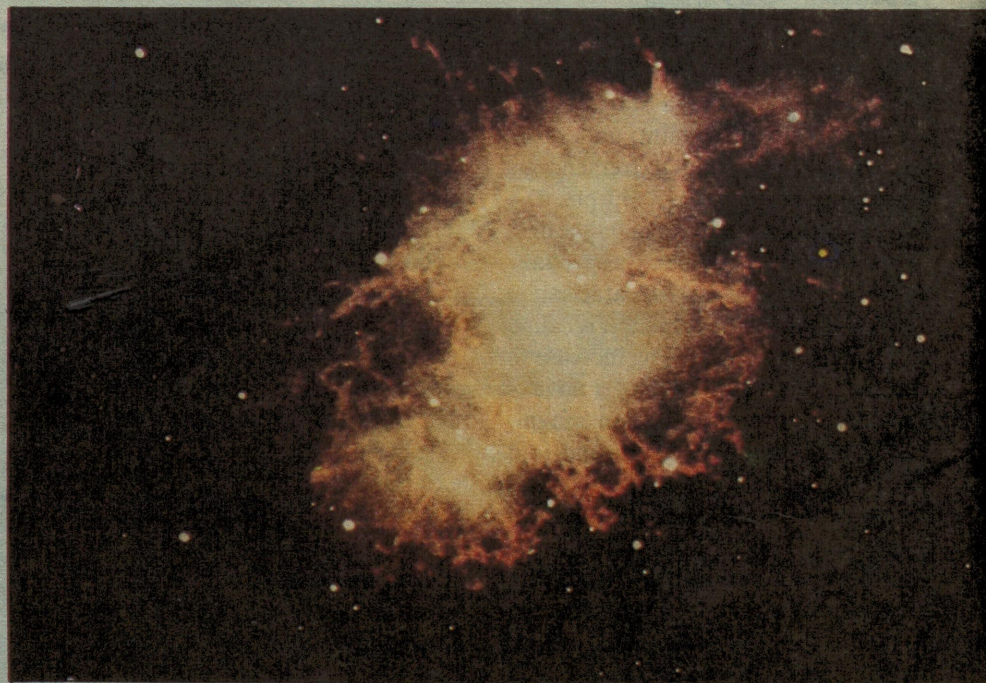
Ring Nebula in Lyra, a planetary nebula

so-called new stars that the heavens do change, astronomers have sought to understand how stars evolve. It has not been easy.

Astronomers see many different kinds of stars in the sky; their objective in looking at these stars is, first, to explain how each kind produces energy and what gives it the appearance we see and, second, to see how it changes from one stage to another. It is only very recently that astrono-

mers have begun to understand the death of stars. Unlike the major part of a star's life, which is long and peaceful, the stage which marks the death of a star can be brief and dramatic—so brief that it may last just a few months and so dramatic that for a few days the star outshines all of its millions of neighbours put together. The lifetime of stars is so long and this last stage so brief that, on average, just one such event in a galaxy of 100 billion stars can be wit-

FROM time to time bright supernovae flare up briefly in the sky. In fact, there have been only five supernovae seen by the unaided eye in the last 1000 years (none since the invention of the telescope in 1608!). At first astronomers concentrated more on determining the motions of the stars and gave only fleeting attention to determining their life cycle. This was because although we can talk of stars being born, growing old and dying, they go through these stages on a very long time-scale and the changes are not usually apparent. The Sun has been as it is for some four billion years. Over a human lifetime, indeed throughout human existence, most stars have remained very much the same. But recognizing from the occasional appearance of



Crab Nebula, about 6,000 light years away, is the remnant of the earliest supernova observed in the Milky Way galaxy in 1054 A.D.

TYPE I SUPERNOVA

1. If one of the stars in a close binary system is a white dwarf (a dense, compact remnant of an ordinary star), its gravity can pull mass from a large companion.
2. When the accumulating mass of the dwarf star reaches an upper limit, a catastrophic contraction begins.
3. The collapsing star ignites in a thermonuclear explosion and is destroyed.



COVER STORY

nessed during a human lifetime. In our own galaxy of 100 billion stars, records survive of only five supernova sightings in the last 1000 years. But astronomers have discovered the remains of not only these five supernovae but of others which occurred many thousands of years ago.

A supernova explosion produces two visible kinds of objects. At the site where a supernova has occurred, astronomers can see the shell of the exploding star speeding into space in

a supernova remnant may sit the hard core of the star that has died, a star so faint that most emit no discernible light, a star packed so tightly by the force of the explosion that a matchbox full would weigh a billion tons. It is called a neutron star.

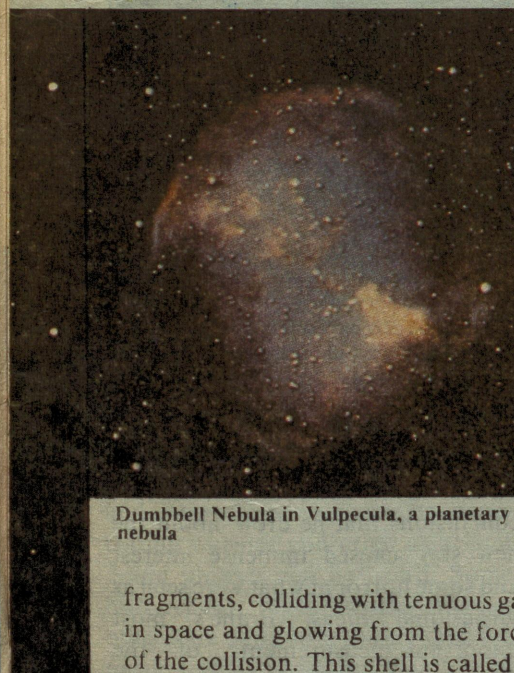
The most studied example of a supernova and its remnant is known as the Crab Nebula. Seen as a bright star in 1054AD, the Crab supernova produced a nebula which was discovered in the eighteenth century. At the centre of the Crab Nebula lies a faint star, the neutron star produced by the supernova. The star is spinning on its axis at a rate of 30 revolutions per second (more than a million times faster than the Earth which rotates once per day). A 'hot spot' on the neutron star shines like a lighthouse into space and, because the beam passes across the Earth once during each revolution of the neutron star, it is perceived as a flash or pulse. It is a pulsar.

The study of supernovae has shed light on other unexplained problems in astronomy, such as how the elements came to be formed (including those in our bodies) and the origin of cosmic rays which are speeding subatomic particles in space. Astronomers believe that cosmic rays originate from supernovae which thus

contribute part of the natural level of radioactivity on Earth. Some even speculate that past supernovae have played a part, through increasing radioactivity due to the cosmic rays, in the evolution of life itself. Thus supernovae, worth studying in their own right, have wide-ranging links with other studies as well as occupying a central position in astronomy.

Occurrences of supernova in nearby galaxies have been rare, but somewhere in the wide universe a few are spotted almost every year through giant telescopes. The galaxies contain hundreds of millions of stars each, but when a supernova occurs, the light from a single star almost equals the total light from the entire galaxy. Along with the increase in the visible radiation, bursts of other radiations are also noticed.

ONLY three supernovae have been very clearly identified in our own Milky Way galaxy and that too only by means of careful analysis of ancient records. The earliest of these occurred in 1054 AD, when it was recorded by Chinese observers. To the Chinese, guest stars were well worth noting and indeed, looking out for. They believed that humans lived on Earth in a kingdom roofed with stars, and that human destiny was subject to a 'Cosmic wind'. Chinese

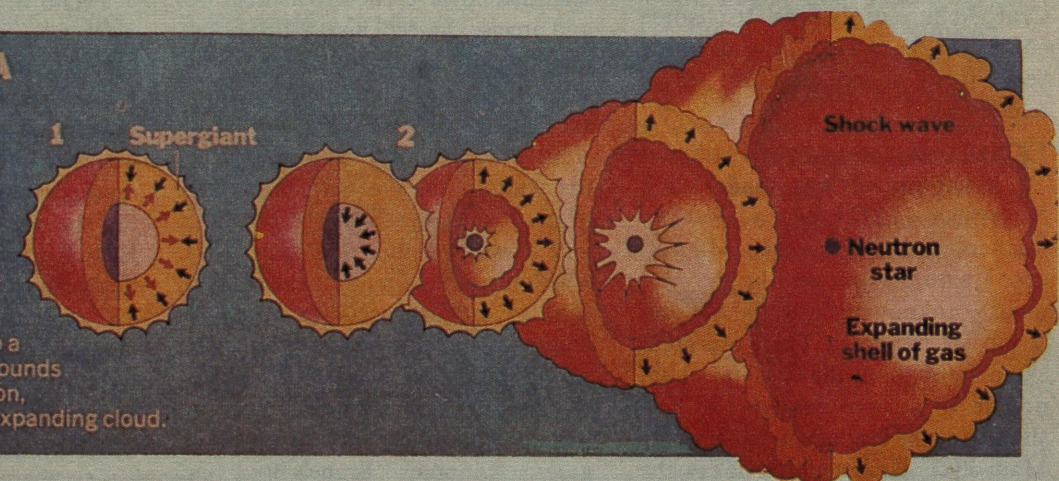


Dumbbell Nebula in Vulpecula, a planetary nebula

fragments, colliding with tenuous gas in space and glowing from the force of the collision. This shell is called a supernova remnant. At the centre of

TYPE II SUPERNOVA

1. Energy from the nuclear reactions in the core of a supergiant star prevent it from collapsing under the force of its own tremendous gravity.
2. When the nuclear fuel is used up, the core collapses into a neutron star. A shock wave rebounds from the core in a huge explosion, leaving a brightly glowing and expanding cloud.

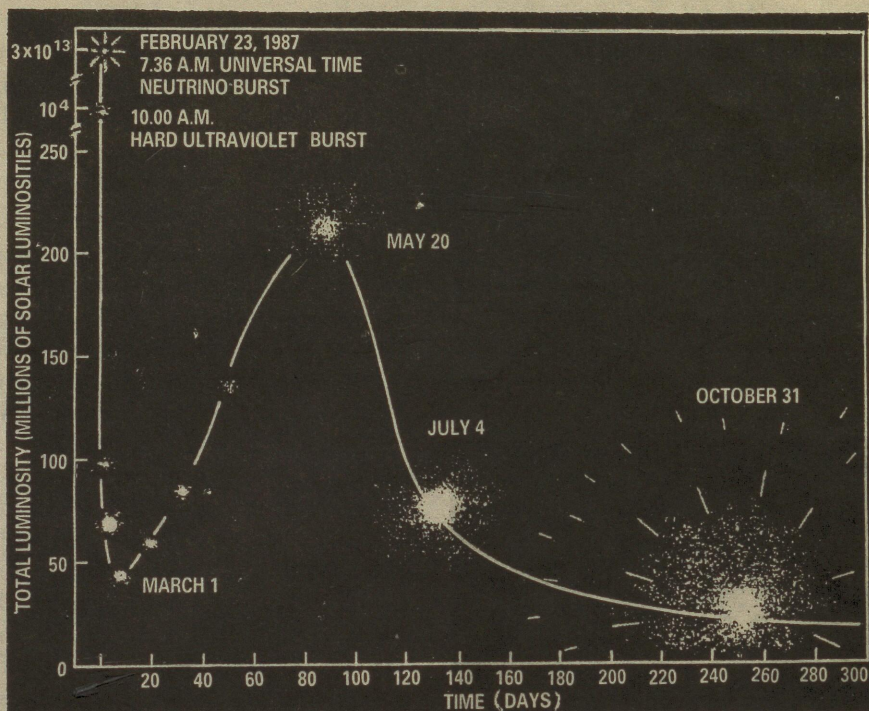


COVER STORY

emperors appointed court astrologers who watched the sky to ascertain the direction in which this cosmic wind would blow their subjects. These astrologers had been noting down celestial events since the fourteenth century BC; these events were believed to mark events of great significance in earthly affairs (such as death of princes). The observations were noted down not as incidental asides but as part of a deliberate policy. Many of these accounts, religiously kept, have survived in official Chinese histories where they are used as background material, illuminating and justifying imperial actions. For astronomers they give details about supernovae whose remnants may still be seen in our galaxy.

In the early morning of 4 July 1054, watchful Chinese astrologers saw a bright new star rising in the east just before the Sun. They called it a 'guest star' because of its sudden appearance in the constellation Taurus. Over succeeding days, the 'guest star' brightened until it outshone all the other stars in the sky. For a period of three weeks it was brilliant enough to be visible in daylight and then it faded until, by April 1056, it had disappeared from sight even on the darkest night. This 'guest star' has since been identified as a supernova. The wreckage of the star is still expanding outwards; known as the Crab Nebula in Taurus. It is some 6500 light years away from us and a very strong source of radio waves and X-rays.

THE first recorded observation of a supernova was made on 6 November 1572 by a Sicilian mathematician, Francesco Maurolyco. He observed a very bright, previously unknown star in the constellation of Cassiopeia. There was great excitement about the new star. 'I am unable to admire enough the new shining of the star of our time' wrote Maurolyco. He noted that he saw the



Explosion of the supernova began with an enormously powerful burst of neutrinos, marking the birth of the neutron star, followed some two hours later by a flash of hard ultraviolet light as the shock wave broke through the surface of the star, heating it to half a million degrees K. Over the next few days the surface of the supernova brightened slowly until May 20, 1987 by which time the shock energy had been spent and then became fainter

star at the third hour of the night and wrote down its approximate longitude and its angle above the horizon. But the man who won fame and fortune from this supernova of 1572 was Tycho Brahe. Brahe, a Danish astronomer, was an extraordinary man. His personal life was wild and undisciplined in the extreme. As a scientist, however, he was meticulous and precise. Indeed, his observations, made before the introduction of the telescope, are recognized as the finest ever made with the naked eye and achieve an accuracy limited only by the acuity of the eye itself. Brahe was at the beginning of his career in 1572 and it was, in fact, the supernova which inspired him to devote his lifetime to making accurate measurements of the positions of the stars and planets. As Kepler, his pupil, said "if that star did nothing else at least, it announced and produced a great astronomer". Brahe's book 'De

Nova Stella (1573)', in which he first set down his observations and the conclusions that he drew 'about the new star' caused immense interest and some horror at what were seen as sensational ideas. Brahe's most important measurements of the supernova of 1572 were of its position.

Tycho Brahe died in 1601 and his work was continued and developed by his former assistant, Johannes Kepler, a German. When the next supernova appeared in 1604, Kepler was working in Prague as court mathematician and tame astrologer for the erratic and probably mad, Holy Roman Emperor Rudolf II. In September 1604, many astrologers' eyes were turned towards the region of sky in which Mars and Jupiter were slowly drawing together. The supernova appeared in the nearby constellation of Ophiuchus and

(Continued on page 17)

FEATHERED MUSICIANS

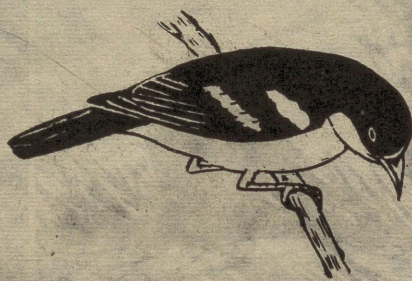


TO a music lover, a spring morning walk through the deep woods can prove to be a sonorous occasion. From the dense wilderness comes the annual outburst of bird music in varying tunes, pitch and rhythm. The participants in this great musical drama include various thrushes, skylarks, orioles, warblers, sparrows, buntings, finches, wagtails, pipits and others. Their rhapsodies, penetrating warbles and other clear and liquid phrases can be heard. Some bird recitals are loud and ringing; others are sung so leisurely that the music sounds sweet and low. It may well be that our forefathers learned to sing and invented musical instruments based on the exquisitely divine music of the birds.

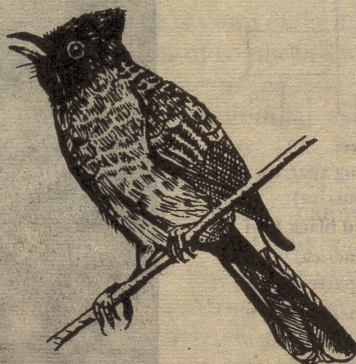
Why Do the Birds Sing

The almost continuous songs of birds in spring mark the commencement of their mating and breeding season. During this period, increasing hormone secretion within the birds' bodies make them sexually active and very aggressive. 'Claim a territory and win a mate' is then each male's ulterior motive. Inevitably, the urge to own a quarter as a prerequisite for gaining a female, and

There is more to a bird-song than simply its melodious and musical quality, says **RAMACHANDRAN NAMBIAR**. Today, bird-songs are not only being analysed for their hidden birdly implications but also being recorded and mass-produced for listening for pleasure



Common Iora (India)



Redvented Bulbul (India)

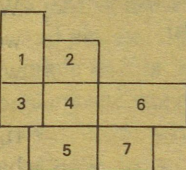
bring up a family, must have resulted in rivalry and fighting between male birds. If this animosity had gone unchecked, the entire spring season would have been wasted in duels causing injuries and deaths to many, ultimately bringing doom to the whole race. Therefore, in the far distant past Nature provided many bird species with a peaceful solution—a musical sound signal called 'song'. With this remarkable device they were better able to communicate with each other and thus respect and acknowledge the other's territorial rights which averted many unwanted battles. The device also promoted reproductive success. The male birds of these species have been singing in spring and summer ever since.

Through his song in the early spring, the male bird broadcasts that a specific area is already taken. The song functions in part as a deterrent to invasion of his 'property' by another male of the same species.

With few exceptions, the female birds do not sing. Furthermore, like many of our own songs, the essence of the bird song in mid-spring is mostly 'love'—the male serenading to an uncommitted female in the neighbourhood, pleading with her to come to him as his bride.

WHY so much vigour and tenacity in the early morning songs? In the pre-dawn and early hours, air turbulence is usually less. Therefore, the male bird chooses this as an ideal time to sing; it may start with a self introductory note indicating the species he belongs to, his sex and other qualifications. In the still morning, this information in the form of sound waves is carried far to male rivals and female birds most effectively. Members of the same species recognise the songster by his voice.

Singing loud and often has an intimidating effect on other males trying to 'sneak' into a domain. To a female bird, however, the sustained songs provide clues to the songster's whereabouts, his health, the sexual cycle he is in now, the boundaries of his 'estate' and so on. Although the same musical message may be repeated many times, the redundancy helps to stimulate the sexual desires of the listening female bird. She is usually attracted by the most melodious and vigorous vocalist. Vigorous in the sense he may not only assure her healthy progenies but may also provide better safety and security to the whole family. In polygamous species such as the North American red-winged blackbird the most aggressive and tireless singer owns and maintains a larger territory and four or five females are attracted and gladly accepted by him. Due to disparity in the quality of their music not all individual males of the same species succeed in acquiring a mate. Some weak males may be just out of luck this year.



1. Parakeet
2. Chirping sparrow (N. America)
3. Winged black bird (N. America)
4. Song sparrow (N. America)
5. American robin
6. Treepie
7. Grosbeak Rose-breasted



Each species has its unique pattern and depth in the song. Hence, an expert can identify the singer without seeing the bird. The song delivery is at its peak before mating and also when another male is singing in an adjoining terrain. In some birds such as the American robins, the male sings much more frequently while his 'better half' is busy incubating the eggs.

The bird often sings from four or five exposed perches called song



posts. This gives the male an unobstructed view and enables him to survey the borders of his 'real estate' (usually 0.1 ha to about 0.8 ha of aerial and ground space); he can also be on the lookout for unwelcome male opponents of his own species. However, some passerines (perching birds) such as the Eurasian skylark and the American bobolink sing while in flight. By autumn, when the breeding season is over and its biological functions have been served, the music dies down and soon the birds may stop singing altogether.

WHICH bird is the finest songster? Is it the European nightingale, the Indian shama or the North American woodthrush? Although these thrushes are regarded as three

of the world's greatest songsters, before choosing the victor their songs should be listened to separately, compared and judged. An unbiased selection of the best of these three can sometimes be clouded with patriotism and love for the most familiar songs of their home birds, especially if the judges are from the participating countries.

As far as quality, pitch and volume are concerned, the nightingale is hailed by many as the finest. Europeans of bygone ages must have heard its song, appreciated it and probably adored this bird. However, much of its glory and popularity came after John Keats's epic poem "Ode to a Nightingale" which he wrote in 1819, two years before his

carry on all through the night. British ornithologist Alan Mitchell, describes the nightingale's song as follows: "a thin, high note, drawn out more and more slowly until a sudden burst of rich deep juggling audible more than a mile away, then loud warble leading to a hard, rapid rattle which ends in a sharp whistle". It is no surprise that Keats wrote about the nightingale:

"Thou wast not born for death, immortal bird!

No hungry generations tread thee down".

A member of the same family as the nightingale, is an attractive and talented vocalist—the shama that flourishes in the ravines and thick forest hill-stations of India and Indochina. Head, back and upper breast of shama are blue-black in colour. The lower breast, however, has a beautiful chestnut plumage. A white rump and a long graduated tail are the other diagnostic features. The latter makes shama look almost double the size of the nightingale.

The song of the shama is truly a masterpiece. It has a rich, multiphased and resonating melody in fairly high pitch which, when heard in the solitude of the thick forest, may have a refreshing melancholy overtone. Getting acquainted with this bird in the wild is not easy, let alone seeing the bird, mainly because it lives in utter seclusion in the deep interior of the forest. However, due to its rich, impressive music and good looks, the shama has attracted world-wide attention. For the same reason hard currency is paid for it and many are kept in cages and aviaries around the world. The first time the author had a chance to look at a shama was in 1989 when he visited Jurong Aviary in Singapore. If voice and physical appearance are the criteria for deciding the best, the shama is definitely in the forefront.

untimely death at an early age of twentyfive.

Nightingale is a bird of the deciduous woodlands of southern England and Mediterranean countries of Europe. There is nothing special about its appearance. The bird's brown upper parts and sober whitish brown plumage under, cannot be called spectacular. But wait until one hears him sing. Soon after its return to Europe from African winter quarters, this singer from deep cover of the woods makes his vocal debut, usually at the twilight hours. He may



Now comes the North American contender and fine singer—the wood-thrush. Some believe that its local cousin—the hermit thrush is a better flutter, but this is a matter of opinion. In any case, the wood-thrush too is a handsome bird with round breast spots, dark eyes and a short tail. From the month of April to the end of July the lovely flute-like notes of the wood-thrush echo through the shaded woodlands of North America. The musical profile in detail includes notes which start in a slow high pitch, then descend with a peculiar bell-ringing sound. The lower notes are repeated giving an unusual sweetness to the song.

How do birds make eloquent and great harmonics of notes? The answer lies in the unique sound box system that some birds possess. Crawford Greenewalt of the Smithsonian Institution, Washington D.C., in the late sixties, was the first scientist to study in detail the birds' intricate ways of making the musical sounds. His intensive research work was later published in *Scientific American*.

LET us briefly compare the musical apparatus of birds to that of humans. In humans, it is the 'adam's apple' or the larynx that produces the voice. Birds too have the larynx, a cylindrical structure at the top of the trachea just below the mouth. But it plays no role as a sound producer. Instead, many birds have developed a highly specialised voice organ called 'syrinx'. It is a cartilaginous box located at the lower end of the trachea and at the junction where the trachea branches out into right and left bronchi.

The structure of the syrinx varies with the species. A vertical section of the voice box of a famed songster will show many structures but most important of them are the internal and external tympaniform membranes, the musculatures, the inter-

clavicular air sacs, and the internal and external labia. These entities in conjunction with the right and left bronchial openings help the birds to produce their distinct musical sounds the same way an accordion or a harmonium produces music through the 'bellows' principle.

When the bird is about to sing, it closes the gap in the bronchi by moving the internal tympaniform membranes into the bronchial openings.



Fig. 1. Taping bird song

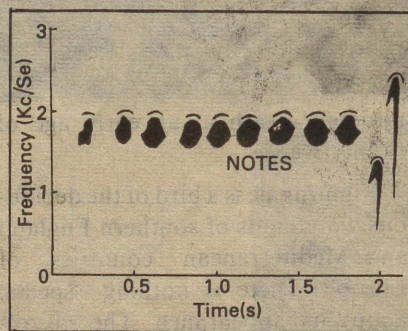


Fig. 2. Sound spectrogram of Nightingale song

Now, air pressure builds up in the interclavicular air sacs. Additional pressure develops as the chest muscles continue to contract. One or both of the bronchial closures are now opened and air is forced through

the tensed internal tympaniform membranes and these membranes vibrate to produce the musical note of a song. The external labia and the buccal cavity modulate the song to a finer quality.

One peculiarity of the bird's sound box is that it is capable of making two notes at the same time. For instance, the British reed warbler commonly produces two notes together, one coming from each bronchus. An even better example is the case of the North American brown thrasher, another celebrated songster. Ornithologist, Robert Burton, has shown that during its concert the male thrasher is fond of making quadraphonic sounds all at once! How this is done is a mystery. Great human vocalists such as Bhimsen Joshi or his western counterpart Luciano Pavarotti, cannot boast of this feat which some of these feathered musicians are gifted with.

Of all the structures associated with the bird's sound box, the number of muscles and their pulling ability on the syringeal rings and internal tympaniform membranes play a vital role in the elaborate vibration and quality of phrases in a song.

Not all birds that utter musical notes can be called song birds. In strictly ornithological sense, those species that possess a strong sound box with multiple pairs of musculatures are the true song birds. The number of muscles varies widely among bird species. Notable songsters such as the North American meadow-lark the British black redstart, the Indian blue-throat and the magpie robins and others may have as many as seven to nine pairs of syringeal muscles. The koel, on the other hand, has only three pairs. Although its vocal skill has been praised by poets, in a real musi-

(Continued on page 25)

COVER STORY

(Continued from page 12)

thanks to the conjunction, observers saw the supernova when it first appeared and when its brightness was still increasing. It is rare for a nova of any kind to be discovered before it is at its maximum light, because the increase from obscurity to full brilliance is so rapid. When Kepler did see the star on October 17, it was very striking. He wrote that it competed with Jupiter in brilliance and that it was coloured like a diamond. This proved to be near the date of maximum brightness for the supernova as all observers agreed that there was no further increase in brightness after October 15. Kepler made arrangements for continued observations to be made, but in November the supernova was too close to the Sun to be seen. It reappeared from behind the Sun in January 1605, by which time it was already fading. It continued to be visible until October 1605 and was carefully observed by Kepler and others until then. This was the last observed supernova with naked eye in our Milky Way galaxy.

Astronomers spot about 20 to 25 supernovae each year through giant telescopes and a total of more than six hundred have been observed. Most occur in galaxies far beyond our own. The only supernova since Kepler's one to achieve naked-eye visibility occurred in 1885 in the central region of the great spiral Andromeda galaxy. This star attained an apparent magnitude of 6.5.

ON the night of 23 February 1987, some astronomical event of historic significance was observed. Ian Shelton, a University of Toronto research assistant working at the university's Las Campanas Observatory in Chile, was taking routine patrol photographs of the Large Magellanic Cloud (LMC), using a 10-inch astrograph telescope originally built for use at the Mount Wilson Observatory some 70 years ago. The Large Magellanic Cloud, is a satellite galaxy to our own galaxy, the Milky Way, and our closest galactic neighbour. It is visible as a hazy patch from the southern skies. When Shelton developed a three-

hour exposure at 5h 30m UT, something remarkable and totally unexpected was on it—a bright star of 5th magnitude lying within the Cloud where previously there had not been one. At first he thought that it might be a photographic plate fault, which is occasionally found. But one look through the eyepiece of the telescope confirmed the existence of such a bright object. Shelton then went out to the balcony of the telescope building and started observation of the fuzzy patch of the Magellanic Cloud and confirmed the existence of a star, bright enough to be seen with the naked eye. For an object to appear so bright at such a great distance, it must be extremely luminous.

Although the LMC is our neighbouring galaxy, it is at a great distance from us—light starting from there would take about 170,000 years to reach us. Shelton realized that he had discovered the rarest of rare astronomical events in the Universe—a supernova. He sent a telegram announcing the discovery to Brian Marsden at the Harvard-Smithsonian Centre for Astrophysics in Cambridge, Massachusetts in U.S.A. Marsden is in charge of the International Astronomical Union's Central Bureau for Astronomical Telegrams, a service that keeps astronomers abreast of the latest astronomical discoveries and developments. As the first supernova spotted in 1987, this one was officially designated "Supernova 1987A"

At about the same time as Shelton's discovery, Oscar Duhalde, the night assistant at Yale's 40-inch reflector telescope at Las Campanas, was on his way to a coffee break. Looking up at the sky he noticed something unusual about the LMC and thus independently found the new star. Duhalde was the first to see the supernova, but the second to report it. A third independent sighting came from amateur astronomer



This X-ray picture shows remnants of an exploding supernova in the constellation Cassiopeia estimated to have occurred in 1657 (U.S.I.S.)

COVER STORY

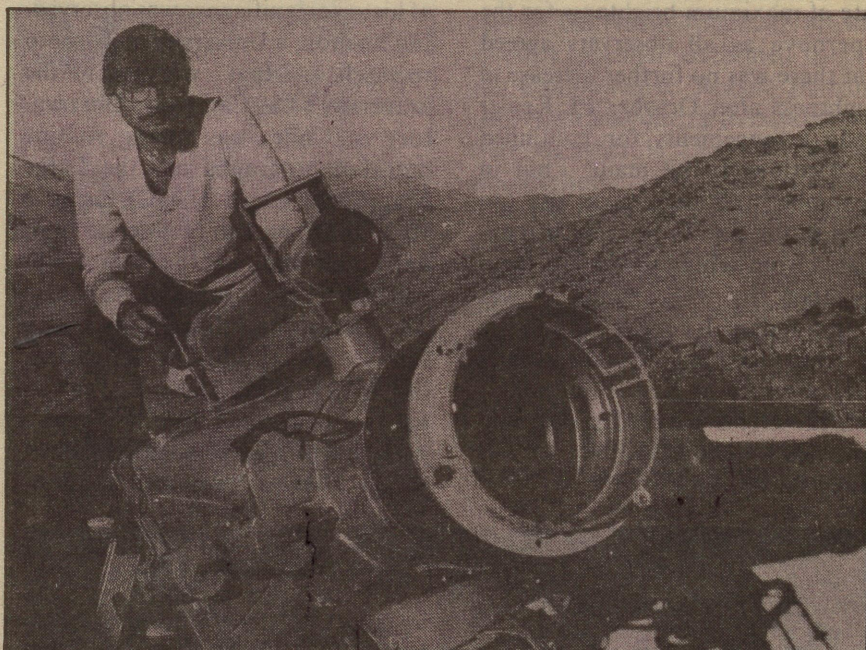
Albert Jones in Nelson, New Zealand at 9.00 U.T. on February 24. As night fell over New Zealand, veteran variable star observer Jones began his regular visual inspection of the LMC, using a 30×78 finder telescope. Despite observing through thin cloud, he saw the supernova. Jones phoned Robert McNaught, an astronomer working at the Siding Spring Observatory in New South Wales, Australia. McNaught was also patrolling the LMC and confirmed the supernova.

THE theory of formation of a supernova may now be explained. In each galaxy, the stars do eventually alter. Nothing in the Universe lasts forever. A coal fire dies when the last embers turn to ash. A star dies when its huge store of nuclear fuel is finally exhausted. Even to-day old stars are fading out, while new ones are being born to replace them. We can see stars in all stages of evolution, from infancy to old age.

How is a star born? Formation of new stars appears to take place in dense, dark gas clouds scattered along the spiral arms of the galaxy. At the earliest stages, it starts with the contraction of interstellar clouds, hundreds of billion times larger than the entire solar system. As the clouds contract, the inside temperature rises and a stage comes when the core temperature reaches around 10 million degrees. At this point, hydrogen starts getting converted into helium and the radiation energy released halts further contraction. This is when the star is born, it starts steadily radiating energy released by the nuclear process in the core. Theoretical work suggests that some sort of supernova should be the inevitable result of the death of every star more than about six times as massive as the Sun, which is a star of middle-age in our own galaxy.

As such a star evolves, it exhausts first hydrogen and then helium as fuels to keep it shining. The next available fuel, carbon, may ignite explosively, blowing the star apart completely. If carbon burns peacefully, other fuels (viz. neon, oxygen, silicon) are used in turn until the star has an iron core, from which no further nuclear energy can be extracted. The iron core gradually increases in mass to a critical value called the Chandrasekhar limit (after Nobel Laureate S. Chandrasekhar,

supernova remnant. The material blasted out by a supernova becomes part of the interstellar gas, the birth place of a new generation of stars. One of the last stages in the lives of stars, produces some of the most fascinating objects in the sky. These are the planetary nebulae. Their regular shapes and beautiful colours make them very attractive. Our Sun is now middle-aged, but can keep the nuclear furnace in action for about another five thousand million years. We need not worry about it's cooling



Canadian astronomer Ian Shelton with his 25.4 cm astrograph telescope at the Las Compañas Observatory in Chile

who first calculated it). The core then collapses suddenly and catastrophically, releasing some 10^{53} ergs of energy. Then comes a stage when the entire outer mantle blows up in a truly gigantic explosion. This is the supernova.

Details of how the energy is transferred to the envelope to blow it off are not very well understood, but may involve neutrinos, additional nuclear reactions and bouncing of the core. The core becomes a neutron star or possibly sometimes a black hole and the outer layers expand as a

off. In the far future, however, our successors will have to colonize the planets around other stars to escape extinction.

Studies of the light curves of the extragalactic supernovae have shown that there are two distinct types, known as Type I and Type II supernovae. Type I supernovae undergo an outburst of astonishing brilliance, attaining absolute luminosities of up to 200 million times that of the Sun. Their light curves are very smooth and are all very similar. Type II supernovae occur much more fre-

COVER STORY

quently than those of Type I, but are much less bright at maximum and consequently more difficult to detect. They attain, at maximum, absolute luminosities equivalent to 10 to 20 million times that of the Sun. Their fading after maximum is much slower than that of the Type I supernovae. Moreover, strong hydrogen lines indicating fast expanding shells of hydrogen are seen in the spectra of Type II supernovae.

ONE of the more exciting features of the 1987A supernova was the possibility of locating the star that exploded. Astronomers would love to study a star destined to be a supernova before the outburst occurs, but they have never had the opportunity because such a star is dim before the explosion. But observations of a pre-supernova star or progenitor, would be extremely valuable and could have a profound impact on our understanding of supernovae and stellar evolution in general. The major problem facing astronomers trying to identify the progenitor was the brightness of 1987A itself. Robert McNaught found that Supernova 1987A coincided with the position of a 12th magnitude star. The suspected progenitor has been identified as the star named Sanduleak -69°202 after the astronomer Nicholas Sanduleak, who catalogued it about 20 years ago. It was a blue supergiant star with a mass close to twenty solar masses and a visual magnitude of 12.36.

As the first few days passed, it became apparent that the supernova's visual magnitude had stuck at around 4.5 i.e. 50 million times brighter than the Sun. The visual light curve reached a maximum of 4.4, around February 27-28, declined to 4.6 on March 5-6 and then gradually brightened to 4.1 by March 20. Its brightness had been flickering by 0.2 on time-scales of 20 minutes to sev-

eral hours. As seen in the infrared, however, the supernova had been continuously brightening, because the cooler gases emit more efficiently at these wavelengths. Conversely, the supernova only emitted significant ultraviolet radiation when the gases were extremely hot. Supernova 1987A slowly brightened for three months before peaking in late May. It captured the magnitude 3.4 on April 15, fiftyone days after the explosion.

At 7:35:41 universal time on February 23, 1987, neutrino detectors in Ohio and Japan simultaneously recorded the burst of neutrinos from 1987A. The Kamiokande-II detector recorded eleven neutrino interactions in 12.5 seconds, the Irvine-Michigan-Brookhaven (IMB) detector eight neutrinos in 5.5 seconds.

THE neutrinos offered the first direct confirmation of the astrophysical theory concerning core collapse and supernova production. More than twenty years ago astrophysicists predicted that enormous numbers of neutrinos would form in the core of a collapsing star. Unfortunately, there were no observations to test the theory. Not until 1987A was there a supernova close enough to Earth for astronomers to observe a supernova's neutrinos.

Both detectors consist of huge tanks of extremely pure water located deep underground. The Kamiokande-II detector contains 2,140 tons of water and is located in a mine in Kamioka, Japan. The IMB detector contains 7,000 tons of water and is located in a Morton-Thiokol salt mine in Fairport Harbour, Ohio. The few thousand feet of earth above the detectors shields them from high-energy cosmic rays, which the detectors would also capture if they were located on Earth's surface.

The detectors were built by physicists looking for a different pheno-

menon. The grand unified theories that attempt to unify three of the four fundamental forces of nature predict that the proton is an unstable particle and physicists have been looking in the tanks for a sign that protons do decay, though none has been detected yet. Luckily the huge tanks of water are also sensitive to high-energy neutrinos, which gave astronomers a fortuitous look into the core of supernova 1987A.

Astronomers were elated and many were surprised at how closely the neutrino observations agreed with theory. Theory predicts that the neutrinos are produced in the collapsing core of the star in just a few thousandths of a second. However, these neutrinos will escape from the supernova over a period of several seconds because the dense core is opaque to neutrinos at the time of neutrino formation. The Kamiokande-II experiment detected supernova neutrinos over a 12.5-second interval, while the IMB experiment captured neutrinos over a 5.5-second interval.

Astronomers used the neutrino observations to calculate the energy carried away from the supernova by all the electron anti-neutrinos. Because the electron anti-neutrinos represent about one sixth of the total neutrinos emitted by the supernova, astronomers next determined the total energy released by all neutrinos— 3×10^{53} ergs. This is roughly one thousand times the amount of energy that our Sun will produce in its entire 10-billion-year lifetime—or the amount of energy the Milky Way galaxy emits in ten years—and the neutrino energy was released in a few seconds.

All of these numbers agree with the standard theoretical models astronomers have developed to explain supernovae. The neutrinos from 1987A escaped after the star collapsed, the emission lasted for several

COVER STORY

seconds, the neutrinos had the right average energy and the temperature and total energy of the explosion were all close to expectations. For the first time astronomers got a close look at the physics of a collapsing star and most of the theoretical predictions turned out to be remarkably accurate.

After two years of hard work, scientists have made a lot of progress toward understanding Supernova 1987A in the Large Magellanic Cloud. Since the new star burst on the scene on 24th February, 1987, it has drawn the attention of thousands of researchers and spurred rapid advances in our understanding of supernovae that otherwise might not have come for many years.

In early 1989, two years after the explosion, the supernova's luminosity was declining steadily, in keeping with the exponential decay of radioactive cobalt-56. The lack of evidence for any energy source other than radioactive decay was starting to puzzle some theorists. The neutrino burst had announced the birth of a neutron star. Yet a neutron star usually emits a great deal of radiation either by heating any material falling into it or by acting as a pulsar: a spinning neutron star with a strong magnetic field that generates a rotating beacon of radiation. Where was the neutron star in SN 1987A? Had it formed initially but then vanished by turning into a black hole? As the supernova neared its second anniversary, most astronomers were still betting on a neutron star, although the exponential decline of the light curve ruled out a very bright pulsar such as the one in the Crab Nebula, the remnant of a brilliant supernova in 1054.

DURING the night of January 18, 1989, universal time, the supernova answered one puzzle with several more. At Cerro Tololo a group headed by Carl Pennypacker of the Lawrence Berkeley Laboratory

and John Middleditch of Los Alamos detected optical pulsations from the supernova. The pulsations, which amounted to about 0.1 percent of the total light, came nearly 2,000 times a second, suggesting a rotation rate three times faster than the fastest pulsar ever seen. Spinning that fast, only the densest, most massive neutron star allowed by theory could avoid flying apart.

Scientists now believe that Sanduleak - 69° 202 spent several million years evolving from a protostar to a star with an iron core, but the iron core collapsed within one-hundredth of a second. The question now is not whether a blue supergiant can explode, but whether Sanduleak-69° 202 was once a red supergiant. One group of astronomers believes that some physical characteristic of the star precluded the star from becoming a red supergiant. The amount of elements heavier than helium could play a role. Heavy elements absorb radiation easier than hydrogen and helium, so a star containing a lot of heavy elements would tend to expand more when its core begins contracting than a star without a lot of heavy elements. The lower abundance of elements heavier than helium in the LMC compared to the abundance in the Milky Way could therefore be a major reason Sanduleak - 69° 202 was blue.

Another group of astronomers points out that there are lots of red supergiants in the LMC. These astronomers believe Sanduleak-69° 202 was once a red supergiant that expelled some of its outer material in a "stellar wind". If this is true, the still expanding shock wave will eventually run into this material and cause it to glow. The IUE satellite has already detected radiation that could be from this material. Continuing observations should provide a more definitive answer.

In fact, observations are continuing at all wavelengths. Theoretical astronomers are making predictions about how the supernova will behave in the next several years and beyond. How close their predictions are to the actual observations will be another important test of our supernova theories. The neutron star is still buried deep within the expanding debris of the supernova and probably won't be visible for a couple of years. One indirect piece of evidence that would indicate the neutron star's existence is the falling off of the supernova's luminosity at a different rate.

SUPERNOVA 1987A will remain an object of intense scrutiny for a long time. As the shell of material expands, it becomes more transparent, opening up like a flower to reveal previously hidden details to Earth-bound astronomers. Doubts about such observations and controversy about their interpretation, bring home an important point about the supernova. In much of science a result is accepted only if it is reproducible. Yet in the case of supernova 1987A we deal with an event that may not be repeated nearby for centuries. When our ability to interpret the observations breaks down, the best we can do is to record and archive the findings carefully, so that future scientists, with greater insight, may come to understand them. Even so, the last two and a half years have yielded breathtaking advances in the understanding of supernovae. For us and hundreds of others, theorists and observers at all wavelengths collaborating to document and explain one of the heavens' grandest events, it has been a time of matchless exhilaration, scientific cooperation and intellectual reward—the event of a lifetime.

Sh. Amalendu Bandyopadhyay is Former Director, Positional Astronomy Centre Calcutta & Fellow, Royal Astronomical Society, London.

Fight TUBERCULOSIS

1. If you are having continuous cough for more than two weeks or if you notice blood in sputum, may be, you are suffering from T.B. of lungs.
2. Get yourself examined especially your sputum at the nearest Primary Health Centre, Dispensary or T.B. Centre.

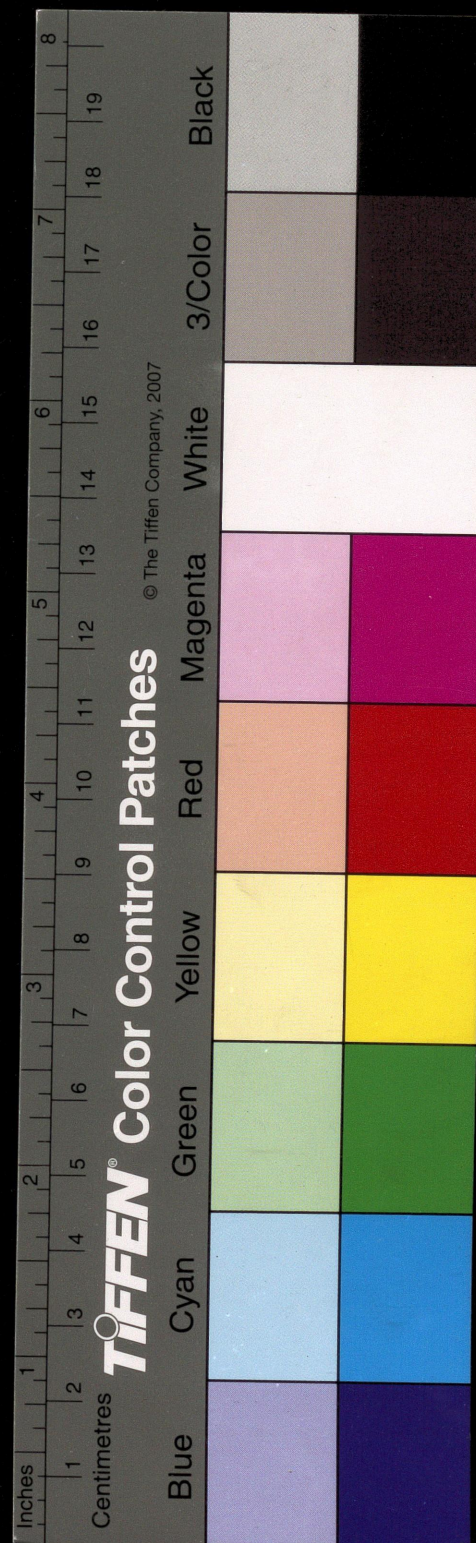


3. T.B. can be cured provided medicines as advised by the doctor are taken regularly for the prescribed period.
4. Prevention is always better than cure. So get your child vaccinated with B.C.G.



Central Health Education Bureau (D.G.H.S.)
Min. of Health and Family Welfare, Kotla Road,
New Delhi-110002.

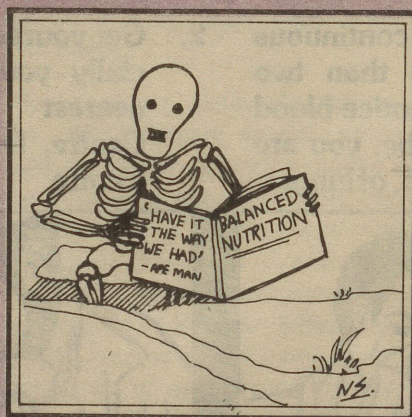
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Hasan Jawaid Khan

Dead Men Tell Tales

BONES of dead men and women tell us a great deal about problems we are facing now. By piecing together the medical records of ancient cultures, palaeopathologists have managed to gain insights into the history of disease. For once, these studies have shaken the notion that man became better nourished and healthier once he abandoned the hunter-gatherer existence for settled agriculture. Far from this, adoption of intensive agriculture was accompanied by a sudden upsurge of diseases because hunters and gatherers had an extremely varied diet needed for balanced nutrition, says George Armelagos, an anthropologist at the University of Massachusetts in Boston, USA.



But early farmers relied on a single grain as a staple diet, the population became dependent on a much narrower diet. This resulted in health problems, some of which persist even today. One example is osteoporosis, a disease that makes bones thin and brittle. On examining thin slices of 5000 year-old bones of Nubian women suffering from osteoporosis, researchers found that their inner portions had been resorbed. The new cells that were replaced on the outer surface of the bone failed to absorb minerals. This indicated a striking deficiency of calcium in the diet. It is therefore recommended that women should increase their intake of calcium.

Mitochondrial Inefficiency Leads To Ageing

MITOCHONDRIA, the storehouse of energy in the cells, may also be responsible for ageing. Researchers have found that we grow old and infirm because mutations build up in our mitochondria. Anthony Linnane and colleagues at Monash University in Victoria working with Takayuki Ozawa and his colleagues at the University of Nagoya, say that DNA carried in mitochondria mutates much faster than chromosomal DNA of the nucleus. Over the years these mutations accumulate and impair the ability of organelles to produce energy efficiently through metabolizing oxygen. Another research group found a marked decline with age in the rate at which mitochondria in



muscle could generate energy-using oxygen.

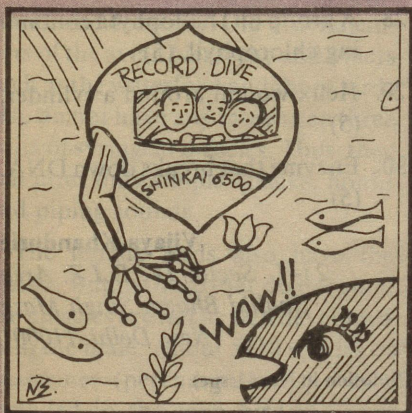
This could explain why the speed at which people run marathons falls with age. Also, a decline in efficiency with which cells generate energy from oxygen could even have a role in senescence in general. Drugs that circumvent particular complexes of defective enzymes in mitochondria might help, to prevent this decline. Respiration at cellular level involves transfer of electrons along a chain of molecules. The so-called redox substances which lose and gain electrons might help this transfer. Ascorbic acid (vitamin C) is one such substance. The others are menadione (a form of vitamin K) and ubiquinol (an enzyme).

Diving To A World Record

A Japanese craft reached the bottom of the Japan Trench off the coast of Miyagi prefecture recently. The dive of 6,527 meters was a world record for an auto-navigating submersible with crew. But the feat was not just meant for the record books. The craft is Japan's newest deep-sea probe, *Shinkai 6500*. The probe

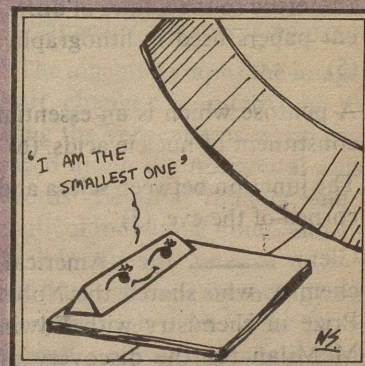
would be used in earnest in 1991 to aid in exploration for minerals on the ocean floor, deep-sea biological studies, and research into the formation of Japanese archipelago and earthquakes. The 9.5 meter long and 2.7 meter wide craft, carrying three crew members, moves underwater at a speed of 2.5 knots (4,630 meters per hour).

The vessel can survey 98 per cent of the world's oceans and 96 per cent of Japan's 200 nautical mile Exclusive Economic Zone which includes Japan Trench. Both *Shinkai 6500* and its support ship, *Yokosuka*, carry much state-of-the-art equipment. *Shinkai 6500* has a highly accurate survey sonar and a robot hand so sophisticated that it can pick up wine glasses and eggs without breaking them. *Yokosuka* uses a multi-narrow beam device to send narrow sonar beams to the ocean floor to measure ocean depths.



World's Smallest Prism

A microscopic prism, thinner than a human hair, was recently created by researchers at the National Institute of Standards and Technology in the United States. The researchers ground the three-sided glass prisms by hand with the aid of a microscope. Each side of the micro-prism is no more than five-thousandths of an inch wide. The prism may prove extremely valuable in telecommunications, where optical fibres are used to transmit huge amounts of data in the form of light pulses. The prism also creates the world's smallest rainbow.



Super Dinosaur

THE enormous weight that the dinosaurs carried may have been reduced by the hollow bones that they might have had. This theory gained currency when researchers from Brigham Young University in the USA unearthed a giant pelvic girdle in Colorado. The two meter long and more than two and a half meter wide fossil pelvis amazed palaeontologists around the world because of its sheer size. Dubbed *Supersaurus*, it was believed to have been one of the largest and possibly the longest dinosaurs to have ever lived.



But experts around the world were further confounded when it was discovered that the hip bone was hollow. Hollow bones have only been found in a few bird-like carnivorous dinosaurs, none of them approaching the size of *Supersaurus*. The researchers speculate that the cavity contained some sort of soft tissue such as bone marrow. Slender struts within the cavity apparently kept the huge bone from collapsing. The hollow bones would also mean that the dinosaur's body was more energy-efficient than previously believed. □

CROSSWORD

Across

1. Satellite of the planet Pluto. (6)
5. Particles, such as photons and mesons, whose numbers are not conserved in particle interactions. (6)
8. Rare forest ruminant animal of Central Africa. (5)
9. Representation of a valence link by which one atom is attached to another in a chemical compound. (4)
10. Surname of the Danish physicist who evolved a new theory of atomic structure. (4)
11. Preferred to the names of different papers used in lithography. (5)
12. A pentose which is an essential constituent of nucleic acids. (6)
15. The junction between sclera and cornea of the eye. (5)
18. Glenn _____, the American chemist, who shared the Nobel Prize in chemistry with Edwin McMillan for the discovery of plutonium. (7)
21. SI unit of magnetic flux density. (5)
22. Surname of the Dutch physicist who did pioneer work in low temperature physics. (5)
23. In a sideways direction. (7)
25. Internal force which resists change in the shape or size of a body. (6)
29. Lumber used for finishing the exterior walls of a building. (6)
31. Severe abdominal pain due to muscular spasm of a hollow viscus. (5)
32. Strip of wood used as a foundation for plaster. (4)
33. Water. (4)

34. Part of the four-dimensional continuum in which matter can be physically extended. (5)
35. Muscular hollow pelvic organ. (6)
36. Tool for gripping and turning nuts, bolts, etc. (6)

Down

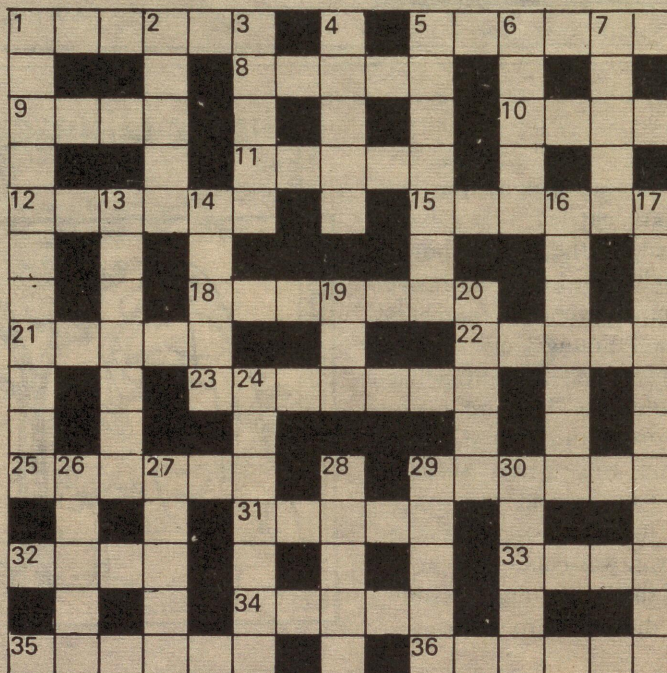
1. The theory of communication and control mechanisms in living beings and machines. (11)
2. Wireless transmission. (5)
3. Obsolete English gold coin first struck by Edward III in 1344. (5)
4. A planet of sun whose mass is around 6×10^{24} kg. (5)
5. Having two magnetic poles of opposite polarity. (7)
6. The oil of skin secreted by sebaceous glands. (5)
7. Who said, "Planning is science in action." (5)
13. Collection of fluid in or under the epidermis. (7)
14. Plant with fleshy leaves which

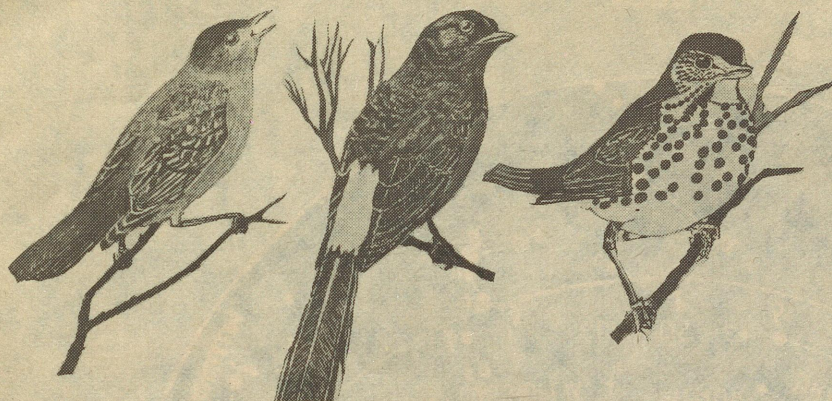
- provide strong fibre used for making rope. (5)
16. Tubes into which the trachea divides. (7)
17. Instrument for recording earthquake shocks. (11)
19. A small four-winged insect. (3)
20. _____ apparatus, which is considered a possible site of synthesis of cellular membranes. (5)
24. Collection of pus in a cavity. (7)
26. Bundle of nerve fibres in the central nervous system. (5)
27. A colourless liquid used as an anesthetic. (5)
28. A group of Thallophyta containing chlorophyll. (5)
29. Helix wound around a cylinder. (5)
30. Enzyme that breaks down DNA. (5)

Vijaya Khandurie

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Shahid Bhagat Singh Marg
New Delhi-110001

(Solution in Next Issue)





Nightingale (6½" Europe)

Shama (11" India)

Woodthrush (7" North America)

(Continued from page 16)

cal sense, the utterances lack substance and dexterity. Old order members of the avian hierarchy and others such as the waterfowl and shore birds also do not have any more than three pairs of syringeal muscles. Thus, they can utter only simple quacks, honks and piping sounds.

The female birds also have the syrinx. But in those that do not sing, the muscles are not as well developed as in the male. About 5110 species of passerines (perching birds) were included in the song bird category previously. However, since they have complex sound boxes with numerous musculatures, and others lack them, recent investigators have assigned only about 3410 species as true song birds. These are known to ornithologists now as oscines. The rest of the passerine species that have fewer muscles and unmusical 'calls' are arbitrarily put in a separate group called non-oscines.

STARTING from ancient cultures, people have been recreating syllables from the songs of birds with a fair amount of verbal accuracy by means of tonal imitation, mimicry and phonetic expression. In Kerala, for instance, the syllable imitation for the distinctive mating calls of the Indian Cuckoo (*Cuculus micropte-*

rus) in Malayalam language is "Chakkak Uppundoe" as if the bird is asking the question 'Is there salt in the Jackfruit dish?'. Eccentric bird listeners in England heard the chestnut-sided warbler male singing "I-wish-to-see Miss Beecher". Bostonian Americans, on the other hand, still claim that the long drawn out whistling songs of the White-throated sparrows sound like "Poor-Sam-Peabody-Peabody, Peabody".

The introduction of tape recorders and spectrograms changed the analysis of bird songs. Vocalization can now be studied by graphic representation for the subtle differences in connotation, tunes and tempos. One method is the recording of bird songs from the marshes, thickets and woodlands on magnetic tapes. The operation is simple. A microphone is attached to a light weight portable tape recorder by a long cable. The sensitive microphone is connected to a broad metal disk or parabola (Fig. 6) which concentrates sound waves. Once the bird starts to sing, the researcher turns the disk in the direction of the source of song and switches on the tape recorder. In certain cases, the operator blows a specialised whistle (Fig. 7) with which he reproduces the song of a particular bird species. Responding to the song, the inquisitive male bird looking for

his adversary is attracted to the scene and may sing at close quarters. Today, recorded music of many birds are on tape and phonograph records and are commercially available.

A common audio-visual aid used in the study of bird vocalization involves the oscillogram or sound spectrum analyser. This simple electronic machine reproduces songs in the form of visual images. The apparatus has a revolving drum wrapped with blank paper. The previously recorded songs are played back and fed into the sound spectrogram by means of a connecting cable. As the spectrogram receives electronic impulses from the tape, it converts them into motion. A stylus makes an ink tracing on the chart paper which is wrapped to the revolving drum.

The machine graphs the images of short changes in pitch and notes along the vertical axis while time is traced along the horizontal axis. It records the total number and the length of individual notes, and changes in loudness or intensity. The vertical lines and their ascending heights show the high pitch of the notes in kilocycles per second while the descending ones indicate the lower pitch. The thick area in the chart shows the loudness. Then, it is up to the researcher to compare the sonogram of one species of bird with that of another and appreciate the sound pattern, timing and quality of song. Most field guides to the identification of birds of recent editions in North America come with a sonogram chart.

Someday we may have a sonogram for the Indian shama also to decide, audio-visually, the merits of its song and probably to declare a winner in the musical contest.

Dr. Nambiar is an ornithologist based in Ontario, Canada (Add: 3386, Hargrove Road, Mississauga, Ontario, L5L, 4E5 Canada)

SKY CORNER

APRIL
Latitudes 0° to 40° N



MAGNITUDES

- MINUS ONE
- ZERO
- FIRST
- SECOND
- THIRD
- FOURTH

24 Jupiter

SKY CORNER

April

THE diagram shows the evening sky as seen from latitudes 0° to 40°N. The inner circle represents the horizon as seen from latitude 22° 30' N. The chart has been extended on the northern and southern sides for use all over India. Beginners wanting to use the chart should hold it overhead and turn it in such a way that the North, South, East and West marked on the chart point to the correct directions. With some experience it would be possible to use it in a more convenient position. With the help of a few known star groups in the sky the remaining stars can be easily identified using the above chart. From a particular place these stars will be seen at about 2130 hrs., 2030 hrs. and 1930 hrs. of local mean time on 1st, 16th, and 30th of the month.

The star chart meant for a particular day for a given hour can be used for the next day 4 minutes earlier and for the previous day 4 minutes later. For example, if a chart is meant for 8-30 pm for 16th April it can be used on 17th at 8-26 pm and on 15th at 8-34 pm. In the same way it can be used for other months; for 16th March it is for 10-30 pm and for 16th May it is for 6-30 pm and so on.

The stars move from east to west in the sky in their daily motion (due to rotation of the earth) at a rate of 15° per hour. The chart can also be used at other hours in the evening after taking into account the above shift in position of the stars.

Planetary Positions for April 1990

Date	1st		10th		20th	
Planets	R.A.	Decln.	R.A.	Decln.	R.A.	Decln.
Mercury	1h 28m	9.9 N	2h 22m	16.6N	2h 55m	19.7N
Venus	21h 46m	12.1S	22h 22m	9.8S	23h 03m	6.6S
Mars	21h 12m	17.4S	21h 39m	15.5S	22h 08m	13.7S
Jupiter	6h 12m	23.5N	6h 17m	23.5N	6h 23m	23.4N
Saturn	19h 45m	21.0S	19h 47m	21.0S	19h 48m	20.9S

Adopted from figures supplied by Positional Astronomy Centre, Calcutta.

The Moon

FULL moon occurs on 10th at 8-48 am and new moon occurs on 25th at 9-57 am I.S.T. The moon passes about three and a half degrees north of Jupiter in the evening of 1st, two degrees south of Saturn on 18th, about three degrees north of Mars on 21st, four degrees north of Venus on

22nd and about three degrees north of Jupiter again on 29th. The moon is at apogee or farthest from the earth on 13th and at perigee or nearest to it on 25th.

The lunar crescent becomes first visible after the new moon day in the evening of 26th.

The Planets

Mercury (Budha), visible in the evening sky, sets about an hour after sunset during the month being in greatest eastern elongation of about 19.5° from the sun on 13th. It becomes retrograde on 23rd. At the end of the month it comes too close to the sun to be visible. It is in Aries (*Mesa*). Its visual magnitude varies from -1.3 to +2.6.

Venus (Sukra), visible in the morning sky, rises about two and a half hours before sunrise during the month. It moves from Aquarius (*Kumbha*) to Pisces (*Mina*). Its visual magnitude is about -4.2.

Mars (Mangala), visible in the morning sky, rises about two and a half hours after local midnight during the first half of the month and about two hours after it during the second half. It moves from Capricorn (*Makara*) to Aquarius (*Kumbha*). Its visual magnitude is about +0.9.

Jupiter (Brihaspati), visible in the evening sky, sets about half an hour before local midnight during the first half of the month and about one and a half hours before it during the second half. It is in Gemini (*Mithuna*). Its visual magnitude is about -2.1.

Saturn (Sani), visible in the morning sky, rises about an hour after local midnight during the first half of the month and at about it during the second half being in quadrature with the sun on 15th. It is in Capricorn (*Makara*). Its visual magnitude is about +0.6.

(Source: Positional Astronomy Centre, India Meteorological Department, New Alipore, Calcutta-700053)

PREVIEW

APRIL 1990

Cover Story : Portable Power

An illustrated review of the developments in battery technology from the historic Volta's pile to modern polymer batteries

Origins of Modern Indian Science

The story of great pioneers like Mahendra Lal Sircar, J.C. Bose, P.C. Ray and others who laid the foundation of scientific research in India

Perils of Innumeracy

Excerpts from a delightful book on our ignorance about numbers

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Kitchen Garden—Tips on growing vegetables in your own backyard

Games with Complimentary Pairs—A few interesting games you can play with dice

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It takes about six weeks to commence the supply of Science Reporter to new subscribers.

Diet And Exercise

OH! the frustration it of all ... Don't eat this and don't eat that, less of this and less of that. Is it any wonder that you are always feeling peckish? Every woman stands in front of the mirror each morning trying to look attractive. She may be satisfied with her hips and thighs but not her waist. She may try various combinations of attire to reduce the apparent size of her stomach. The mid-section continues to haunt her. It is the psychology of women today who feel too fat, even if they are five pounds underweight. The current body image in vogue is ridiculously slim and almost all women aspire for it. Unfortunately, women are programmed to be fatter than men, to lay down more fat cells and to store more fat.

It has been observed that women are generally more critical of their bodies than men are. They are more fussy about their own appearance, physical fitness and sexuality. Even little girls learn to value beauty. But the psychology is that the more often they diet, binge or purge, the more likely they are to dislike their appearance. Loss of control and excessive restraint in eating seem to be part of a self-defeating struggle resulting in a negative body image.

TODAY's therapeutic strategy for weight control is self-regulation or dieting. Remember, dieting is not that simple. Every time you go on a diet, your metabolism slows down as the body tries to protect itself against the loss of fat stores. And, when you go off diet, your metabolism does not immediately return to normal, so you gain weight

and go on another diet, setting up a vicious cycle.

The general idea of dieting is cutting down calories which is, in fact, an old way of thinking and overlooks several essential elements of healthy dieting. Also, cutting calories is rather too broad a statement; what you need most to do is cut fat calories. And just cutting fat calories will take you only so far. You must also



exercise. When you combine a low-fat diet with exercise, the result will be a leaner body with a more efficient metabolism.

During the past decade, a great deal of attention has been focussed on the role of dietary fats. Good nutrition is a basic component of

health and is of prime importance in the attainment of normal growth and development and in maintenance of health throughout life. Prior to discussing the role of dietary fats, it is important to know that the major dietary constituents of food are proteins, carbohydrates, fats, vitamins, minerals and water. Foods rich in carbohydrates, are energy yielding—grains, cakes, bread, honey, vegetables, fruits, milk, roots, tubers, cereals, sugar, etc. Meat, eggs, liver, fish, milk, pulses etc. are rich in proteins and are body building foods.

The fat which we eat gets burnt in the body to produce energy while some is continually being stored. This comes from ghee, oil, cheese etc. It may also be formed from carbohydrates and protein. Besides these, there are protective foods which are rich in proteins plus they contain vitamins and minerals. These include milk, eggs, liver, green leafy vegetables and fruits. Out of these food constituents the main importance is given to the intake of carbohydrates and fat. Both these are essential but the amount varies from individual to individual. The whole diet chart is based on these two constituents for reducing weight, maintaining weight or increasing weight. In fact, complex carbohydrates are the key to ultimate weight control. Round out your diet with fruits and low-calorie vegetables such as green leafy ones, carrots, cauliflower or green beans.

WEIGHT gain if neglected may become a health hazard. Research suggests that location of fat storage is more important healthwise than merely the amount of fat. The weight men gain usually around the abdomen is far more dangerous to

FOR HER

their health than the fat women tend to accumulate in their thighs and buttocks. Dietary fat has recently been targeted by leading health professionals as a probable cause of the primary source of calories in our diets. It obviously makes sense to reduce the fat content of your diet, whenever possible.

But can one escape weight gain or obesity without dieting or reducing fat calories? Why not? One way is to be blessed with very good genes. The genetic contribution to obesity, though not fully understood is very strong, much stronger than society allows overweight people to believe. Genes may make metabolism more efficient or increase the number of fat cells or stimulate fat cells to deposit more fat. The second way to lose weight is to exercise. No matter what your genetic predisposition is, exercise helps increase your metabolic rate. The third way, is to be born male. Men are more likely to exercise, less likely to be genetically predisposed toward fat storage and they seem to have a higher metabolic rate. Physiology too is important in the development of obesity. You may have observed that fat people remain fat. What actually happens here is that initially your fat tissue changes. With overeating, you increase the size of your fat cells which can then store more fat and when the cells cannot store any more, you increase the number of fat cells which surely make you look obese.

It is interesting to know what makes one put on weight. When we eat complex carbohydrates like cereals, bread, cheese etc., the insulin levels rise and fall off gradually. But when we eat simple sugars like sugar, candy, pastries, etc., the insulin levels rise quickly and drop sharply although it varies depending on the particular food. Besides, glucose levels in the blood are also affected dif-

ferentially. The net result is that we are more likely to eat again an hour or two after eating simple sugars than after eating complex carbohydrates. Also, the kind of food we eat at one meal affects what and how much we eat at the next. A number of hormones too are responsive to the content of a meal. All these factors together affect hunger, perceived pleasantness of food and the amount of food that is consumed later. In addition, there is a whole cascade of responses to the sight and smell of food; for example, changes in salivation, gastric secretion, free fatty acid levels, insulin and so on. Externally responsive people may have higher levels of all these responses. Such responses prepare all of us to digest and metabolize food effectively. The problem is that, with conditioning, these digestive responses become associated with increased hunger making people with the largest insulin surges to eat more than others; resulting in weight gain.

ALL heavy weight individuals may not always need cut down on weight. It depends on the height, weight and the amount of fat present. It is difficult, however, to measure the percentage of body fat for each one of us. Fat is measured by hydrodensitometry or underwater weighing. Fat tissue is less dense than the non-fat tissue and therefore more buoyant. If two people of the same weight have different level of body fat, the one with more fat will weigh less underwater. The other widely available method for measuring body fat is the use of skinfold calipers. This involves measuring the thickness of folds of skin at a minimum of three points on the body; usually the triceps, the front of the thigh and the abdomen. The thicker the folds the more subcutaneous fat a person has. Once measured, the different readings are plugged into an

equation that yields an overall percentage of body fat. Thus, individuals with excess body fat can seriously think of dieting.

Any diet program should be built on a sound foundation of good nutrition. You need not become an amateur nutritionist to reduce the fat in your diet. The important thing to know is that each gram of fat contains nine calories. Changing the way you cook can satisfy your taste-buds with high-taste, low-fat substitutes for the foods you crave. You can achieve and maintain a desirable weight level by reducing the amount of cholesterol and fat, especially saturated fat such as oil and ghee and increasing the consumption of carbohydrates and dieting fibre.

EATING lots of fruits, vegetables and grains is beneficial since these provide both fullness and good nutrition at a reasonable calorie cost. Proper diet and a good fitness program improves more than just your body—it shapes up your mind too!

Women in urban areas do require to diet and exercise. This may not be the case for rural women. Their lifestyle is such that they eat a proper and simple diet plus they do manual work which keeps them healthy and fit. You would rarely see an obese rural woman. In cities, especially, far too many of us are in poor physical condition. Physical fitness for the masses is slipping away every year. We are getting mechanised in everything we do today. Our homes are electric with washing machines, mixers, grinders, dough makers, juicers etc., the housewife must beware lest she get calloused fingers from pushing buttons.

There are more than 400 skeletal muscles in the body. They are responsible for movement of the joints, maintenance of posture, support of body weight, circulation of

FOR HER

blood and respiration and elimination of wastes. Studies conducted by the U.S. National Aeronautics and Space Administration (NASA) scientists show that unexercised muscles deteriorate at a phenomenal rate. Just as a body cannot store certain vitamins but must have them regularly, it likewise cannot store certain of the conditioning effects of exercise. Those parts involved in our usual daily regimen remain in rea-

If you are driving a car or even riding in, pull in your stomach muscles every time you stop for a signal. Hold them tight until you start the car again.

DON'T ride elevators, walk up at least a floor or two. Actually, walking is the best exercise one can have. Brisk walking helps circulation of blood throughout the body and thus has a direct effect on your over-

one leg and hold for six seconds. When you take the baby out of the crib, slowly lift it overhead four or five times. As you wash your vessels or bend over the sink for washing hands or vegetables and grains, do deep knee bends slowly.

EXERCISES can be done while working both at home or office. You heard a tinkle of the phone, stop, do not answer the first ring, instead sit there, pull your stomach muscles in tightly and hold until the second or third ring. After a neighbour or a guest leaves push yourself up from your chair with your arms, keeping your legs extended.

With such daily-on-the-job exercises, you can gain strength and with more strength you will not have the fatigue and pain. You might also cut out some of your snacks and lose the extra weight. There can be several other fitness programmes which include yoga, aerobics, swimming, cycling or other rigorous exercises in a gymnasium. But it is much easier and simpler if you make a list of exercises you can do daily as you go about your tasks. Exercises help chase away the blues; even modest exercise can help prolong life. Remember, people who care about beauty, health and fitness have positive feelings about their appearance. A concern for fitness and health is closely linked to a satisfying body image. People who feel good about their bodies are happier and better adjusted and that is what we call as a psychological well-being. It is not that each one of us should win a beauty contest but it is essential to take care of our body-image because without it one would not exist.

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sonably good tone but those parts we do not use get weaker.

The only answer seems to be to make exercise a part of your daily activities. Most people say they don't have time to keep fit. That is not true. You can exercise at all times, say, when you are brushing your teeth, pull your stomach muscles in tight and pinch your buttocks together. Combing your hair is also a type of exercise where you can pull your abdominal muscles in or give your hands a lifting exercise and the longer the hair better the exercise! Stand on one leg when you put on your underwear or jean, pant or salwaar instead of sitting down. If you walk to a commuter train, take big steps, breathe deeply and walk on your heels to stretch your heel cords.

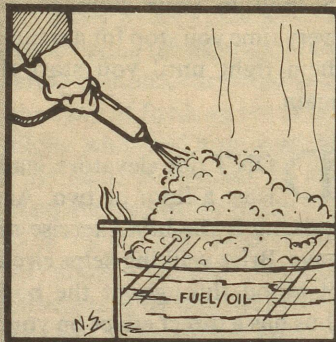
all feeling of health. There are 60,000 miles of blood vessels in the body, mostly capillaries; those minute vessels are responsible for irrigating the flesh. Only a few capillaries will open when a muscle is at rest. Perhaps, 50 times as many will open when the muscle is being exercised. So, walk while you are on an errand, walk the short distance between transportation point and office or hit your stride down corridors and home compounds. More than that, you can go back on your age and start skipping. It is an effective fitness exercise, convenient, inexpensive and enjoyable.

Stretching exercises can be done while making the beds. Every so often, stop whatever you are doing for a moment, rise on your toes on

BRAINS TRUST

- Q.** How is it that fire in oil tankers is not extinguished with water?

Chandramohan Singh
Kali Prasad Inter College
Allahabad



- A.** Fires involving oil, spirits and other inflammable liquids require a special technique of extinction. One of the most effective method of dealing with such fires is by the application of

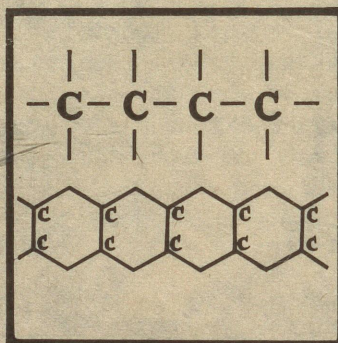
foam, a light frothy substance resembling soap-suds, which floats on liquid. It is applied until a foam blanket covers the entire combustible surface and smothers the fire.

If water alone is used for extinction in the form of spray or stream, it would simply disperse the oil and spread the fire.

C.B.S.

- Q.** Why has the element carbon maximum number of organic compounds?

Birendra Prasad
Q.No. E-541 Fertilizer's Colony
Gorakhpur-273 007



- A.** Carbon is an element which is most abundant in nature. It is found in three allotropic forms as coal, graphite and diamond. Carbon atom is tetravalent, i.e., it can combine with four atoms. The four bonds of carbon atom are directed towards the apexes of a regular tetrahedron. Consequently, the compounds formed by carbon are very stable.

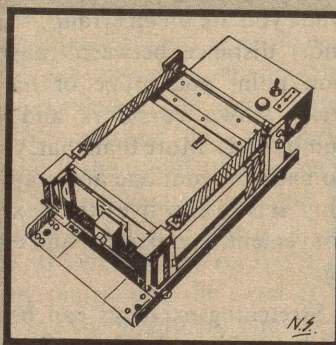
The carbon-carbon skeleton forms a long chain or a ring, or both. Such compounds are found in nature in a large number and are the basis of life. They constitute a separate branch of chemistry—organic chemistry.

Sometimes the carbon-carbon structure also takes up atoms of another elements such as oxygen, hydrogen, nitrogen, sulphur etc. Compounds of such type are also in large number and are dealt with under inorganic chemistry.

C.B.S.

- Q.** What is a "Black Box"?

Arun Kumar Gupta
Block Road, Jainagar (Bihar)



- A.** The name 'Black Box' is a misnomer. Actually it is a generalised term for a self-contained unit of electronic circuitry which may not necessarily be black. In aeronautics this device, known as flight recorder, records data on the functioning of an aircraft

and its systems on a tape. The recorder is contained in a crashproof, floatable box which is ejected in case of an accident and is usually fitted with a homing radio beacon and flashlight to reveal its presence. In routine flights of airliners it traces faults for maintenance control. By analysing the data stored in the black box the cause of failure of the aircraft can be known.

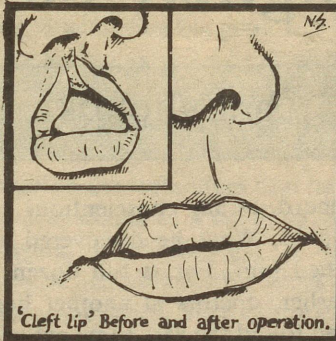
C.B.S.

BRAINS TRUST

Q. What is plastic surgery?

Narendra Kumar Sinha
P.O. Makhdumpur (Saraiya)
Dist. Jehanabad (Bihar)

- A.** Plastic surgery means any surgery that changes the shape of the body or to remove tissues from one part of the body to be used at another part. It developed during the First and Second World Wars. Hindu physician *Sushruta*, used skin grafts as early as 800 B.C. to reconstruct a damaged nose.



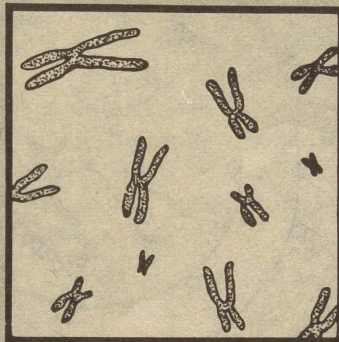
Also known as cosmetic surgery, it may be used to give a better appearance to the face of a patient, i.e., by straightening or reducing the size of nose, sagging tissues under the chin, cheeks and eyelids. Many congenital deformities such as cleft palate and harelip can be corrected through plastic surgery. In case of severe burns skin from other parts of the body is grafted immediately or at a later date to improve the scars that may develop.

C.B.S.

Q. What is genetic engineering?

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- A.** Many prospective parents seek professional help in determining the chances of their offspring being born with a genetic disorder. This is particularly so with parents who have a family history of genetic disorders. Sickle-cell anemia and Tay-Sachs disease are examples of the types of



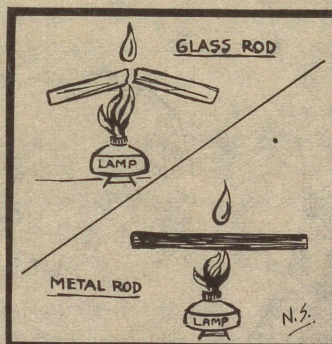
disorders where genetic counselling is advised.

We are hopefully looking forward to the day when genetic disorders can be diagnosed and treated. The branch of medicine aiming at this objective is known as genetic engineering. In near future scientists may perfect means of removing defective genes from chromosomes and substituting normal genes in their place.

C.B. Sharma

Q. Why does a heated glass rod cracks, while a heated metal rod does not when a drop of water falls on them?

- A.** All substances, whether glass or metal, undergo thermal expansion when heated. Metal is a good conductor of heat and electricity, while glass is *not*. Thus, whenever a temperature gradient is created in any localized region of a metal, due to its high thermal conductivity heat flows in localized region is at a lower temperature than its vicinity or flows out to neighbouring regions, if these are at lower temperature. In either case, the temperature is quickly



levelled and the metal retains its crystalline structure. On the other hand, glass being a poor conductor of heat, no such levelling of temperature can take place. Thus, when cold water drops on any region of the glass rod, contraction of that region due to fall in temperature takes place, whereas the lattices of the neighbouring regions remain unaffected. The lattices of the contracted regions may develop elastic fissures and the glass rods may crack. However laboratory waves made of Pyrex glass do not break as the glass practically has no thermal expansion.

R. Sambasivan

Designed To Kill

BAL PHONDKE

COLUMBUS did not set out to discover America. When he set sail from the shores of Spain his sights were set on India, the land of milk-and-honey, sugar-and-spice. He never reached that destination but landed in a whole new-world. This is yet another manifestation of the phenomenon of serendipity.

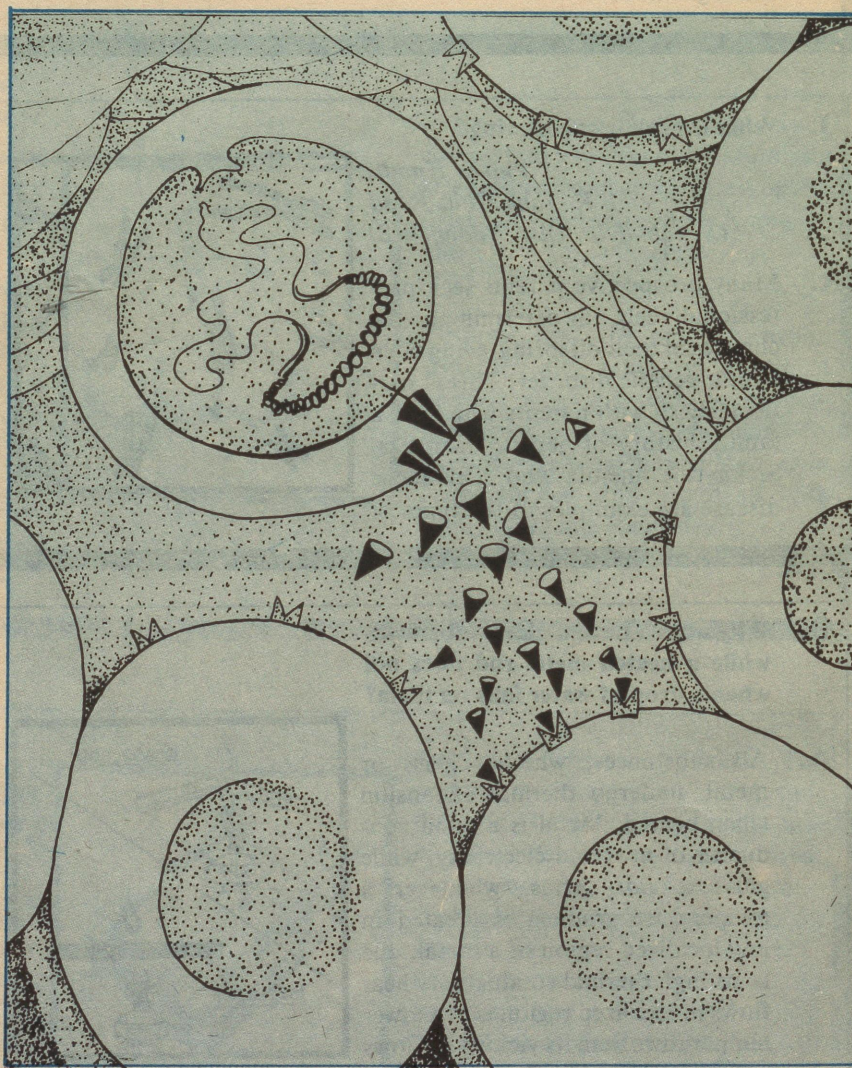
There is no dearth of such serendipitous discoveries in the world of science. Many a scientific Columboes have accidentally set foot in territories they had not begun to travel to. Times without number scientists have made such fortuitous discoveries of phenomena they did not even know existed. At times they got waylaid along this new path into woods lovely, dark and deep forgetting for ever what their original destination was. At other times, they conquered the new territory without abandoning the march towards the original goal. Either way the journey has been memorable, not only for the individuals concerned but also for the mankind at large.

STEVEN Rosenberg is one such scientific Columbus. He had set out to become a surgeon and had started training for it in right earnest. He was, however, bitten by the curiosity bug and inspired to chart a different course in 1968. The trigger for this change of direction was provided by a patient who came to him for the removal of gall bladder stones.

Before commencing surgery, Rosenberg went meticulously through the patient's past medical

record, as any conscientious doctor would. What he discovered astonished him. For, a full dozen years earlier, doctors at another hospital had found the very same patient suf-

fering from apparently incurable cancer. When they had opened his stomach on the operating table they were confronted with a tumour, the size of a fist, with infiltration in the



Tumor attack. Tumor-infiltrating lymphocytes, or TIL, launch an attack on a melanoma from which they originated

BIOTECHNOLOGY

nearby lymph nodes indicating that the cancer had spread its tentacles far and wide. With little hope of ridding him of the dread disease, they had merely cut out the most visible tumour, more in order to provide some short term relief than a long term cure and allowed the hapless man to go home and pass his few remaining days in the midst of his near and dear ones.

Yet the same person long given up for dead, was in front of Rosenberg, all hale and hearty save for the stones in his gall bladder. When Rosenberg operated upon him he found no trace of the cancerous spread. Rosenberg quickly realised that this was a case of what in the medical parlance is known as "spontaneous remission".

The origin of cancer is also considered spontaneous since its emergence cannot be attributed to any known single cause. Likewise, there are cases when it apparently disappears on its own without any definitive therapeutic procedure accounting for it.

That does not, however, imply that doctors do not have any theories or concepts about the mechanism by which this curious cure is brought about. The most favoured theory postulates that the immune system—the defence force of the body that repels attacks by inimical infection agents—is responsible for stemming the cancerous invasion.

FASCINATED by the first hand experience of a spontaneous remission Rosenberg naturally started wondering if he cannot imitate or duplicate nature and bring succour to the unfortunate victims of cancer.

Thus started a sustained research effort aimed at harnessing, and strengthening, the immune system to beat back the advancing army of

malignant cells. After a prolonged, dedicated effort lasting over twenty years, Rosenberg has not fully succeeded in achieving his goal. But he has reached an extremely promising stage indicating that he has established a firm foothold in the new territory. What helped him consolidate his position are techniques that have become available as a result of fast developing biotechnology. In the process he has widened the scope of biotechnology itself. Such a snowballing effect has characterised the advance of this newly emergent discipline.

While carefully reading the patient's case history Rosenberg had noted that soon after the earlier surgical operation the patient had contracted a severe stomach infection. As a result he had developed virulent pus formation. Even a cursory survey of literature regarding spontaneous regression showed that a similar phenomenon had occurred in many of the reported cases.

This planted the seed of an idea in Rosenberg's mind. It was given further nutrition when he noted that the patient's stomach cancer had been infiltrated with lymphocytes—the vanguards of immune attack.

Rosenberg felt convinced that the tumour had vanished in the face of an assault by activated immune lymphocytes. Further, the infection was somehow responsible for arousing specific cancer-killing lymphocytes. Thus, the concept that the immune system does try to prevent cancerous development seemed to be vindicated. To transform that precept into practice, however, was the major task that Rosenberg had to tackle.

That particular patient of his had been fortunate enough in the sense that nature had performed the job that Rosenberg was wanting to do. But, in most other cancer patients, the task cannot be left to the vagaries

of nature. Man had to intervene and mimic nature.

The immune lymphocytes were waiting to attack the cancer. An opportunity had to be provided to them to get their act together. Also, they had to be strengthened and their ranks burgeoned.

NONETHELESS, it was a challenge that had to be taken up. The first step was to identify the waiting cells and to gather them. That turned out to be relatively easier, since some lymphocytes that had infiltrated the tumour could be isolated.

These cells, called simply the tumour infiltrating lymphocytes (TIL) seemed to be rather unique among the immune cells as they were found to be specific to the tumour from which they were extracted.

When TIL obtained from a patient's melanoma (a type of tumour) were grown in the laboratory and later re-infused into the tumour they were seen to attack only that patient's melanoma. Not only were other melanomas spared but also the surrounding healthy cells of the same individual were left unscathed. Further, it was also seen that the reintroduced TIL were able to hunt out specifically melanoma cells located anywhere in the body and then zero in on them like homing pigeons or rather homing hawks.

So the recruits were available. But their number was inadequate. Moreover they had to be better equipped and their combat skills refined and honed. Those were daunting tasks. Even increasing the number of TIL proved to be difficult. For at the time of Rosenberg and his colleagues were carrying out these experiments, it was not possible to grow lymphocytes in the laboratory. And the few TIL that could be harvested from the body were just too few.

What Is Cloning?

A 'Clone' in the strictest sense means an exact duplicate. Xerox copies of a document can be said to be clones of each other. Likewise individual replicas of an industrial product manufactured in a factory using mass production techniques can be considered as clones.

However, in the biotechnological sense the word assumes much greater significance. Even here, media hype has led many to think of cloning as the creation of genetically identical cells or organisms derived from a single ancestral cell. But more often than not geneticists employ the same term to imply production of identical copies of genes, rather than cells or active organism. More precisely, cloning involves isolation of a gene from a higher multicellular organism containing coded instructions for the synthesis of a desired protein product

and its subsequent insertion into a unicellular organism, mostly a bacterium, with a view to obtaining a large number of its exact copies in a very short time as well as to get them to produce the protein in sufficiently large quantities.

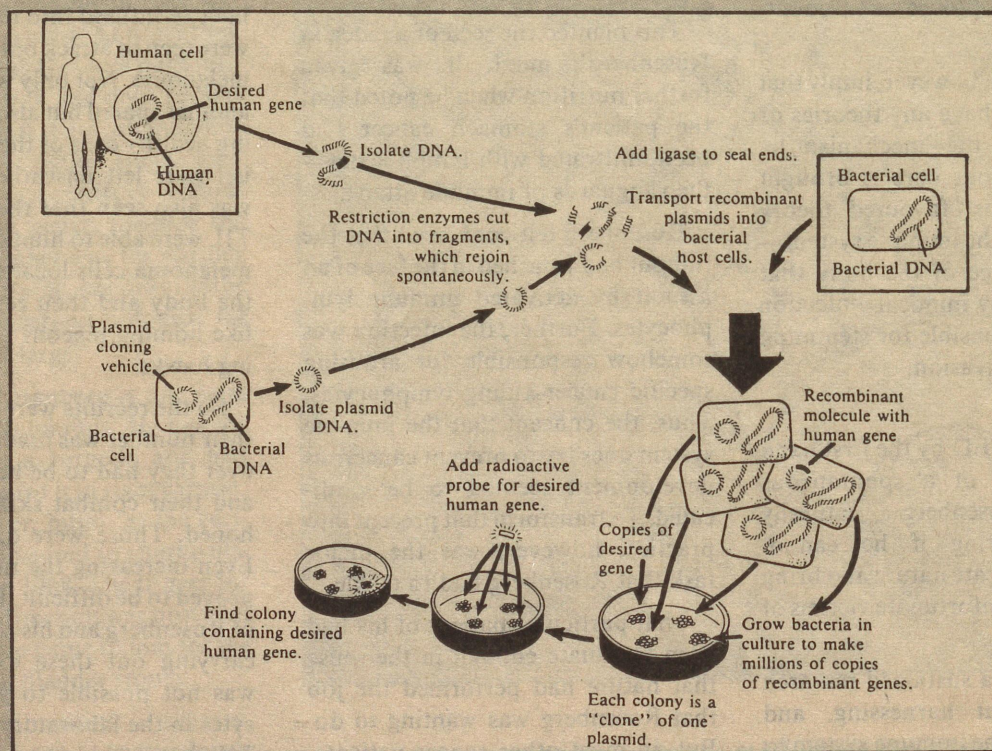
The whole process, therefore, consists of five distinct steps each involving consummate skills to orchestrate a string of sophisticated chemical reactions. The first step is to identify and isolate the desired gene from, say, a human cell. At the same time a bacterial workhorse, say, *Escherichia coli* is chosen and DNA from its constituent plasmid is taken out. Both the DNA molecules are then cut into pieces using a type of chemical scissors called restriction enzymes. The resultant pieces are then mixed so that they spontaneously rejoin. Now a chemical sealant, called ligase, is used to seal the loose ends. Such recombinant DNA is then trans-

ported back to the bacterial cell.

The next step comprises growing these recombinant genes in host cells. Since bacterial cells can be easily grown in a laboratory and since their doubling time is a matter of hours, a large population of these cells, each carrying an exact replica of the recombinant gene, is available in a very short time.

The recombination has taken place randomly. It is, therefore, not yet known which of the cellular colonies contain cells that carry the desired human gene. The fourth step, therefore, concerns itself with screening the various colonies with the objective of finding out precisely those that possess the particular gene.

Once that is obtained, the gene is said to have been successfully cloned. What remains is to grow the clone in large numbers and then get it to synthesise and secrete the required product.



An Overview of the Gene Cloning Process

BIOTECHNOLOGY

Yet the concept could not be just abandoned merely because there were these logistic difficulties in putting it into practice. Like in most research one had to carry on regardless, putting in hours after frustrating hours and wait patiently for striking a possible solution.

The perseverance paid. For a few years later Robert Gallo at an institute not far from where Rosenberg worked reported finding a growth factor made in the body which made the lymphocytes grow in large numbers and very fast too. The substance was called interleukin-2 (IL-2).

So Rosenberg started using IL-2 and made another discovery—again serendipitously. Cells grown with the help of IL-2 themselves turned into killer cells. They were christened as lymphokine activated killer cells (LAK).

OFF went the research along another track. If IL-2 generates such killer cells, then would not giving the cancer patient IL-2 alone bring about the necessary recovery, argued some scientists. Rosenberg too found merit in this argument. He, therefore, started a number of trials both in humans and animals. The results were depressing, but not in a way that would mean abandoning hope altogether. For it became clear that the amount of IL-2 given to a patient was not enough to generate enough LAK. And if greater amounts of IL-2 were administered then they were seen to be toxic to the patient.

That gave Rosenberg the idea of growing LAK outside the body in adequate numbers before sending them or their hunt inside the body. The idea was great but did not work. On the one hand, the LAK did not appear to make a distinction between the normal cells and the cancerous cells. They seemed to kill both with equal enthusiasm. On the other, they

did not seem to cause any significant shrinkage of the tumour.

Rosenberg and his team were thus back at square one. But research scientists are not easily dissuaded. Such failures as they had experienced are not uncommon to them. They focussed their attention on the TIL now. Instead of using any lymphocytes and train them to kill with the help of IL-2, they thought, it might make sense to impart that skill to the TIL which had already shown fair degree of specificity for the tumour from which they were isolated.

This time, the team of scientists tasted success for a change. This therapeutic approach did appear to work and result in some discernible reduction in the cancerous mass. That did not mean, however, that all the troubles were over or all the obstacles were crossed and left behind. Because, to get sufficient numbers of TIL to be effective litres and litres of IL-2 was needed. And even after the large number of TIL so obtained was infused it had to be followed by continuous injection of IL-2 to maintain the number of TIL inside the body at the optimum level.

Again research work at a different laboratory proved to be a boon for our Scientific Columbus. For just about that time the gene for IL-2 was "cloned". This meant that the gene containing instructions for the synthesis of DNA of IL-2 was taken out of the parent cells and by employing the recombinant-technique was introduced in a bacterial cell that could be turned into an IL-2 manufacturing factory.

Thus armed, Rosenberg and his co-sailors on this scientific expedition were ready to disembark upon the land they had sighted in order to capture that territory. In 1984, they encountered a patient, a 29-year old nurse who had melanoma that had

spread almost throughout the body. Her case appeared hopeless and she would normally have had to count her days. She was given LAK and also IL-2. Within days of treatment, the cancers began to melt away. Within a month and a half all tumour was gone. Today many more patients have escaped what earlier would have been certain death. The doctors have gone on to refine the treatment even further so that the adverse side effects are kept to the minimum and within manageable limits.

THE protocol which now appears simple is a fine example of what biotechnology can achieve. Take a cell that naturally makes IL-2. Isolate the gene responsible for the production of IL-2. Clone it, making it possible to manufacture IL-2 on an industrial scale. Then remove surgically a small piece of the tumour and isolate the lymphocytes that have infiltrated. Place these TIL in a sea of nutrients containing IL-2 to increase their number a millionfold. Reintroduce these TIL into the patient's body and sustain their number by regular injection of IL-2.

Though enthused by the success of his therapeutic regimen Rosenberg and his team are at pains to emphasise that the therapy is still experimental. It would take quite a few more years of sustained and painstaking research before it becomes routinely available to patients all over the world.

But the beginning has been made. Biotechnology is being harnessed to design tailor-made cells that can destroy a tumour. Rosenberg has plans to go even further. He is thinking of transferring a gene for other anti-tumour substances inside the TIL so that when they go on the attack they have more than one type of ammunition. The pace at which biotechnology is marching ahead, that day should not be far off. □

Semiconductor Memories

MUKHTAR AHMAD

THE memory or storage is an integral part of any digital computer. It is required to store data and programs without which a computer cannot function. All large computers have a main memory and an auxiliary memory. The main memory is fast, i.e., it has less access time, and communicates directly with the Central Processing Unit (C.P.U.). The CPU works as the brain of a computer and performs all arithmetic and logic functions. Small computers may not have auxiliary memory. The devices used as main memory are either magnetic cores or semiconductors. The semiconductor memories are the most commonly used memories now. In less than twenty years, these memories have evolved rapidly from a simple transistor circuit capable of storing a single bit (Binary digit) to Very Large Scale Integration (VLSI) memory chip, which can store more than one Megabit of data. The solid state integrated circuits invented in 1958 incorporated all the necessary circuit elements like transistor, diode, resistor, etc., in a single monolithic Unit. These circuits were small in size and inexpensive. The dramatic growth of semiconductor technology has been responsible for making available low cost and small size memories. Basically, a memory consists of an array of storage cells and a set of auxiliary circuits for selection of these cells. As a computer memory cell should be capable of storing binary information, it is nothing but a flip-flop. A flip-flop is a bistable multivibrator circuit, which has two stable states known as 'high' and 'low' states.

The semiconductor technology

used in the manufacture of memories is mainly Metal Oxide Semiconductor (MOS) technology. This technology has a "field effect" transistor as the basic circuit. The "Bipolar" technology, which was the first integrated circuit technology, was used for memory construction only before 1965. The basic difference between a bipolar transistor and field effect transistor is that the former is current-controlled whereas the latter is voltage-controlled. The field effect transistor (MOS) has three electrodes, with gate situated in between the source and the drain. The level of voltage at the gate controls the flow of current between the source and the drain. As far as processing and fabrication is concerned the MOS technology for memory construction has many advantages over bipolar technology. The MOS memory requires less number of processing steps, has greater electrical flexibility and greater element-packing density. Here MOS memories only will be described in detail. The semiconductor memories are classified as:

- Read/Write memories or Random Access Memories (RAM), and
- Read Only Memories (ROM)

Random Access Memories

In a Read/Write memory or RAM, data can be written into or read out of any storage location in random fashion without regard to its physical location relative to other storage locations. Thus a RAM consists of memory cells arranged in array form along with an auxiliary circuit for selection of appropriate cell. The information at the selected cell may be read or modified by writing a new data in that cell with

the help of control input. The semiconductor read/write MOS memories can be either static or dynamic. In static RAM, the basic cell of the memory (a flip-flop) is made with the help of two static inverters. An inverter is a circuit that converts a digital input signal to its opposite state, i.e., a zero or 'low-voltage' state into a one or 'high' state, and vice versa. A simple inverter circuit using MOS technology is shown in Fig. 1.

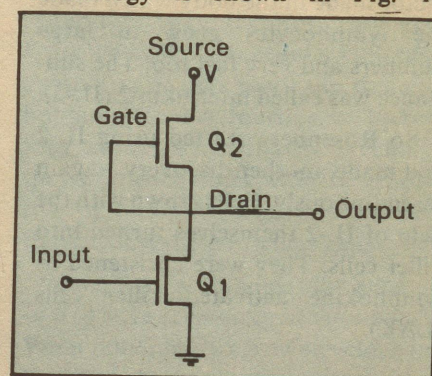
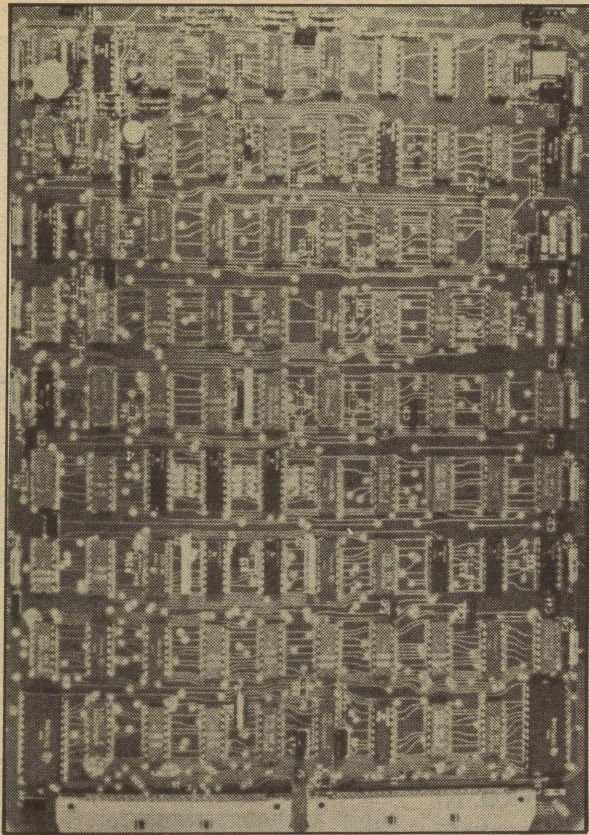
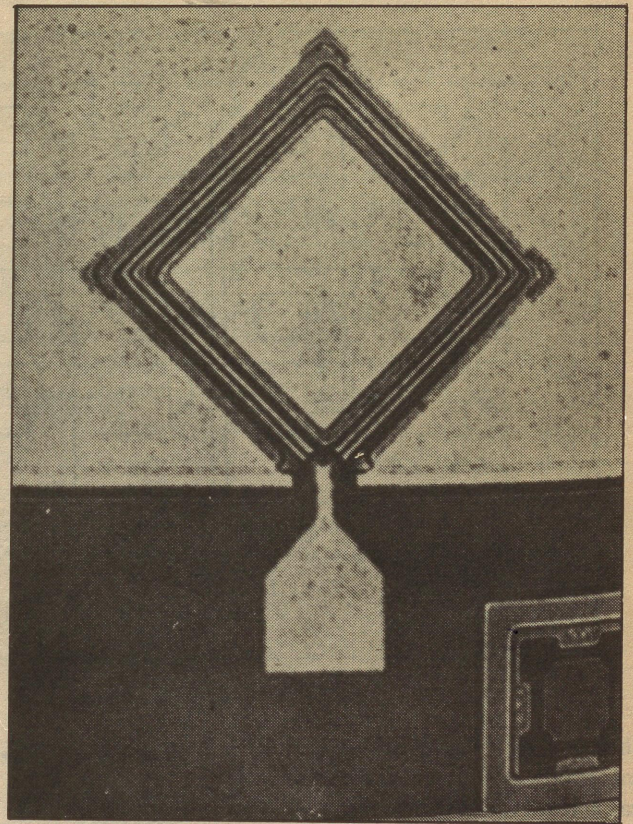


Fig. 1. A MOS inverter

Transistor Q_1 works as a switch whereas transistor Q_2 works as a resistive load. When the input is low or zero the transistor Q_1 is in 'off' state and the output is 'high' or 1. If the input signal is 'high' or 1, transistor Q_1 is turned on and the output is shorted to ground, making it low or zero. Two inverters cross coupled as shown in Fig. 2 form a latch or a memory cell. It has two stable states, i.e., output (1) is 'low' and output (2) is 'high' or output (1) is high and output (2) is 'low'. The state of this latch can be changed by a brief external signal. An input signal, which turns Q_1 off, results in high output (2) which turns Q_2 'on', and results in low output (1). When this storage cell is to be used as RAM, two more transistors Q_3 and Q_4 are connected at input and output respectively. These transistors work as two-way transmission gates and are connected to the word line and bit line. A 4×4 configuration of 16 bit



A Microprocessor Unit



Photomicrograph of a silicon field effect transistor

memory is shown in Fig. 3. If a word is to be read from memory, the appropriate word line is energized. This turns on the transistors at the input and output of that cell, and the cell input and output is connected to the appropriate bit line. The difference between output (1) or input and output (2) states is sensed

by the sensed amplifier. The bit lines are kept at supply potential; then the current will flow in the output line if the output (2) is in low state. If a word is to be written at a particular location of the memory, the appropriate word line is activated and appropriate signals are applied to bit lines to put output (2) in low or

high state as desired. Since the static cell is stable in either of the two states the content of the cell is maintained, provided the supply remains connected. However, if the supply goes off, then the contents of the memory are in unknown state or the information is lost. These memories are therefore called 'Volatile' memories. For random access memories, the general practice is to select only one bit of the data at the output of the package for reading/writing. A word is then built by connecting a number of memory packages in parallel, the number of packages being equal to the number of bits in the word. The word length chosen is a multiple of 8 bits, e.g., 16, 32 or 64 bit.

Dynamic Random Access Memories (DRAMs)

A dynamic MOS memory cell for use in a random access memory is

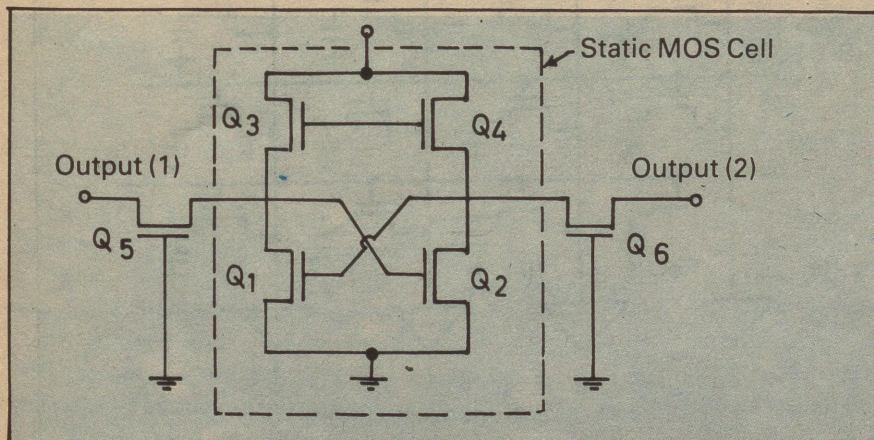


Fig. 2. Static MOS cell along with input and output switches

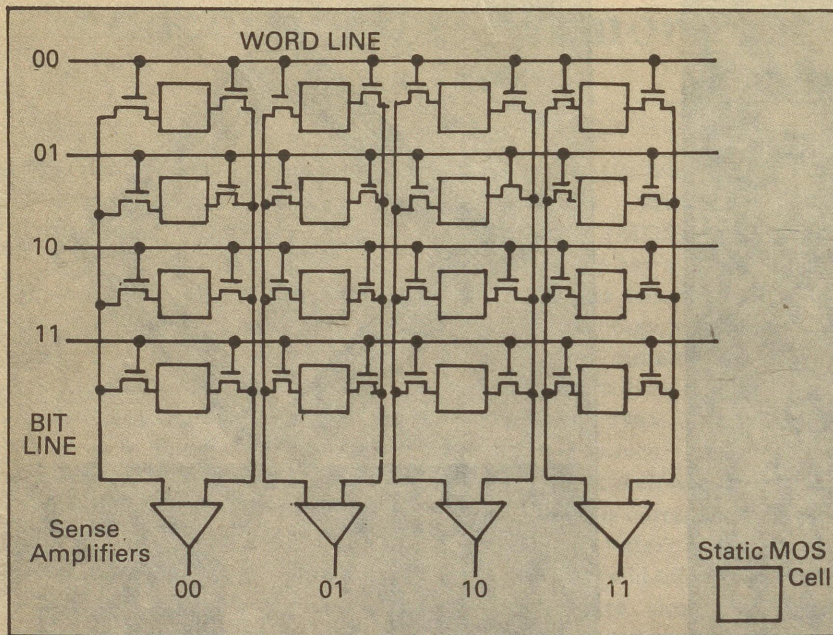


Fig. 3. A 4 × 4 static MOS memory

shown in Fig. 4. Here the information is stored as a charge on a capacitor of MOS transistor. The presence of the charge indicates 'high' state of logic and its absence 'low' state. Since the charge can remain stored only for few milliseconds, hence the name 'Dynamic'. The present DRAMS use a simpler cell containing a single transistor in series with a capacitor as shown in Fig. 5. As reading of this cell can be accomplished only by the discharge of the capacitor, it must be rewritten after each read cycle. A 4 × 4 array of dynamic RAM is shown in Fig. 6. To read the content of a particular location, a voltage is applied to the appropriate word line which switches on the transistor of that location and connects the capacitor to the bit line. A sense amplifier compares this voltage with the reference voltage to determine the state of the cell. To write into the specific location, appropriate word line is energized along with the bit line either in 'high' or 'low' state according to the content to be written in that position. The word line is then switched off.

Read Only Memories

Read only memories (ROMs) contain a permanent data pattern stored during the manufacture of the semiconductor chip. The storage element in the cell of ROM is simply a contact to voltage source which

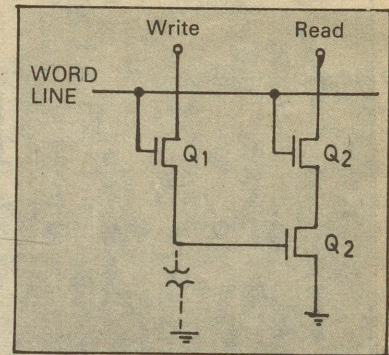


Fig. 4. Dynamic memory cell (3-Transistors)

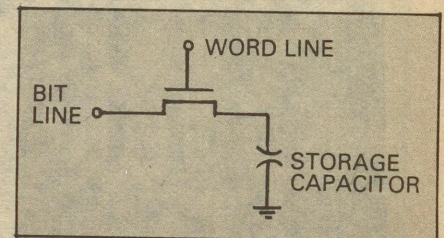


Fig. 5. A single transistor MOS-DRAM cell

corresponds to '1' or 'high' value of logic. Thus the cell of a ROM has only an access transistor. The 'low logic' or '0' is stored by disabling the gate of access transistor so that the

(Continued on page 46)

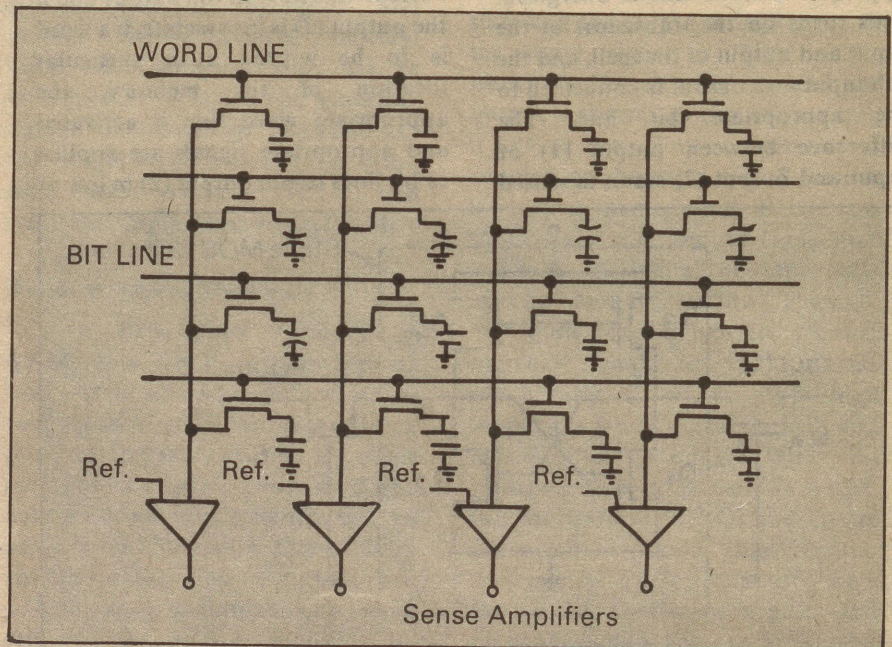


FIG. 6. A 4 bits X 4 bits DRAM

Fever?... Don't Shiver

"Nina, why do you look so pale? Anything wrong with you?"

"Nothing much Doc! A little fever, I suppose!"

"Fever? Since when?"

"Don't worry Doc! I get fever every now and then these days. I am not worried... It will go Doc!"

"Never take fevers lightly, Nina. Let us examine you now!"

"No Doc! I am O.K.!"

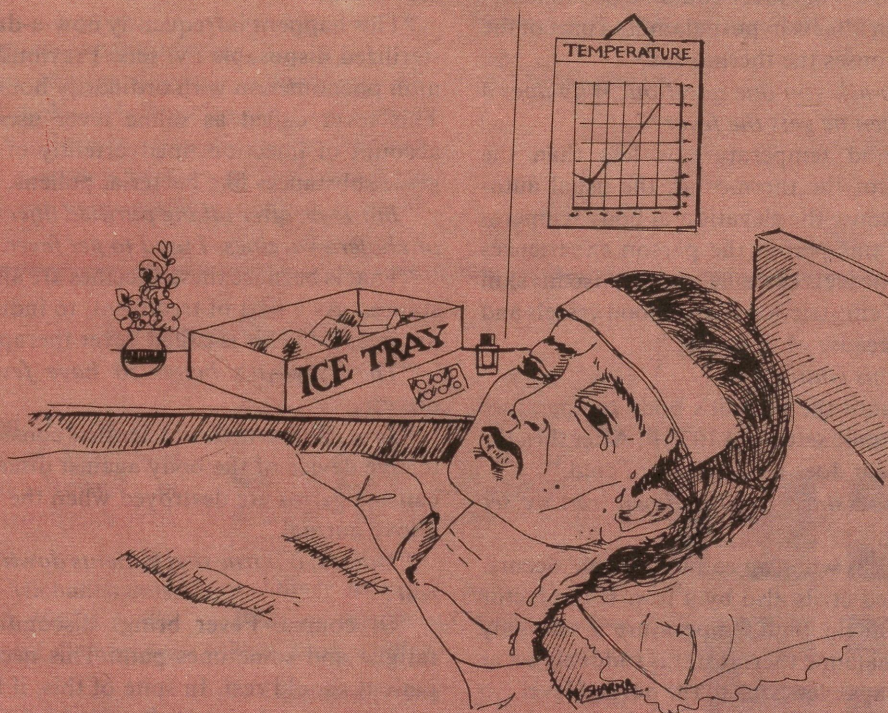
"No Nina, don't neglect it. Fevers could be dangerous. Do you know that?"

"Really Doc? Then first tell me, why do these fevers develop? What is fever? What does it mean?"

"By the way, before we proceed further, do you know what are normal temperatures?"

"Yes! of course, I do. The normal temperature is 36.2 degrees-Celsius or 97.2. degrees-Fahrenheit."

"Good. The temperature rises above this level, it may be termed as fever. Although fever is defined as an abnormal increase in temperature, it is not always easy to determine when an increase in temperature is abnormal. This is especially true of the lower temperature readings. If the temperature is 37.7° C (100° F) when measured by mouth, or 101° F or above as recorded by the rectum, fever is almost decidedly present. However, a mouth temperature of 37.2° C (99° F) may or may not be fever



"Right! Fever is a warning that there is some disturbance in the normal bodily processes!"

"That, we too can make out Doc! We feel unwell! But how exactly does this fever develop?"

"If you are asking me about the exact physiological mechanism of fever, the answer is 'I don't know'. But do you know that there is something known as the temperature regulating mechanism of the body?"

"Yes Doc! I have heard about this. But I do not know the exact details."

even though the reading is above what is usually called as 'normal'—98.6° F, 37° C—corresponding to the arrow on the thermometer scale."

"How is that Doc? The 'arrow' means a normal temperature, isn't it?"

"No! Not always. The manufacturer's arrow indicates normal temperature on the basis of a statistical average, and this is by no means the normal temperature for everybody."

"Thank you Doc. But you were telling me something

CLINIC

about the temperature regulating mechanism."

"Yes. I will tell you about that. This temperature regulating mechanism is situated in the human brain. It does work like a thermostat, used in industrial equipment for the maintenance of various temperatures."

"Does this human thermostat go out of action when one develops a fever, Doc?"

"Not exactly! Many proteins, breakdown products of proteins, and certain other substances such as (lipopolysaccharide) toxins secreted by bacteria, can cause the 'set point' of hypothalamic thermostat to rise. Substances that bring about this effect are called pyrogens. It is pyrogens secreted by toxic bacteria or pyrogens released from degenerating tissues of the body that cause fever during disease conditions. That's why, I told you not to ignore your fever—however insignificant it may be!"

"But Doc, even in serious diarrhoea especially in children, there is a fever....."

"You are right Nina. That fever could be due to dehydration. Dehydration affects hypothalamus, a part of the human brain, that houses the thermostat"

"Doc, I wanted to ask you one question. Why does a person get chills, when he gets the fever?"

"Because the blood temperature is less than the temperature setting of the thermostat, the usual autonomic responses to cause the elevation of body temperature occur. During this period the person experiences chills, during which he feels extremely cold. Also his skin is cold on account of constriction of the blood vessels and he shakes all over because of shivering."

"How long does this continue?"

"This continues until the patient's body temperature rises to the hypothalamic setting of 103° F. After this, the chills stop. The patient does not feel hot or cold."

"If this temperature starts coming down, can we see any signs?"

"Good question. Yes what we call as a 'flush' occurs. Sometimes it is called crisis also by a few. If the factor that is responsible for the high temperature is suddenly removed, the hypothalamic thermostat is suddenly set at a lower value—perhaps even back to the normal level. So the blood temperature is still 103° F, but the hypothalamus is attempting to regulate the body temperature at 98.6° F. This results in excessive sweating and sudden development of a hot skin. A doctor always waits for this flush, as it's good news for him as also for the patient,—the fever is coming down!"

"Doc, how high can fever go? Isn't that harmful?"

"When the body temperature rises above approximately 106° F, brain cells usually start getting damaged. Body cells also get damaged. There are spots of haemorrhages. Most dangerous thing is that the damaged brain

cells can never recover. When the body temperature rises above 110° F the person usually has only a few hours to live unless his temperature is brought back within normal range rapidly by sponging his body with alcohol or by bathing him in ice water."

"Doc, in summer we see some people getting heat-strokes. Some die..."

"That is a different story Nina. That is a different topic which can be discussed at length later. In brief, I can tell you only one thing that this happens on account of the failure of the thermostat mechanism, which is put out of gear by high atmospheric temperature. On account of this, once the body temperature rises above 107° to 110° F the heat regulating mechanism often can no longer dissipate the excessive heat being produced. Therefore the temperature may then rise abruptly until it causes death unless the rise is checked artificially."

"Thank you Doc. We get fever when saline is injected, isn't it Doc?"

"This happens infrequently now-a-days on account of sterilized disposable i.v. sets. Previously, it was a common phenomenon with ordinarily boiled i.v. apparatus. This fever called as saline fever used to develop on account of injection, inadvertently of course, of pyrogenic substances like bacteria, pollens, dust."

"But Doc, after taking purified injections like typhoid or cholera vaccines, I used to get fever."

"That is because these vaccines are also pyrogenic substances. As a part of treatment, to induce fever vaccines are injected. This is called 'fever therapy'."

"They say—it's better to have fever. It fights the disease."

"True. Some medical scientists consider fever as a protective device of the body against disease. Some disease causing germs are destroyed when the temperature rises above normal."

"Doctor, is it true that patients down with fever should rest?"

"Of course. Fever brings discomfort, weakness or fatigue and sometimes pain. This necessitates that the patient should rest. In spite of this, if he is ignoring the advice for rest, he is not allowing his body to conserve his energies for the battle against the disease."

"What are the other effects of fever, Doc?"

"In a patient suffering with fever, there is a sensation of soreness in muscles and bones. Headache, thirst, loss of appetite, constipation, a coated tongue, dry skin—are other symptoms. In children, a sudden onset of high fever may bring on convulsions and delirium, although illness itself may not be serious. In fever, the pulse rate is likely to increase at the rate of about eight to ten beats per minute for each degree of temperature rise."

CLINIC

"Doc! What about food. Some people starve during fever."

"That is wrong. The metabolic rate—the speed of chemical reactions in the body—also increases during fever. For this reason, even though the appetite is low, the need for food may be greater than ever. The need for fluids is definitely increased."

"Doc, upto now we are talking about fevers only. But what are the normal temperatures?"

"Normal temperature for most individuals is 37° C (98.6° F). A few people have a normal level which is 0.5° C either above or below this."

"So, Doc, above this temperature, means a fever?"

"With lower temperature readings it is not always easy to determine when an increase in temperature is abnormal. If the temperature is 100° F by mouth or 101° F or above by rectum, fever is almost decidedly present. However, a mouth temperature of 99° F may or may not be fever, though the reading is above the manufacturer's normal-arrow!"

"Which are the diseases causing fever?"

"The list of fever causing diseases is unending. All infectious diseases, malaria, tuberculosis, even common cold, sore throat, influenza, measles, boils, infected wounds, any inflammatory process in body such as appendicitis, cholecystitis, pancreatitis, hepatitis, all of them result in fever."

"Enough, Enough Doc! I am scared enough. I will not ignore my fever now. I am frightened enough—however I wanted to ask one last question..."

"Go on..."

"How should we handle a fever patient?"

"The feverish patient should drink plenty of water and take as much nourishment as possible in frequent but light meals and fluids such as broths, juices, *kanjees*, or *khichdis*. You must call on your doctor. Do not be your own doctor! Do you know that I go to a doctor-friend of mine if I get fever. The doctor may prescribe fever-reducing medicine such as aspirin, sodium salicylate or paracetamol. More important than this is that you should take antibiotics as advised by your doctor. Do not stop their intake, because you felt better. In cases of extreme fever (39° C) it may be advisable to cool the patient in a bath of cold water. Warm, tepid baths are also recommended in some instances. Alcohol ('Brandy') sponges may be helpful. Of course, such methods should be used only under medical supervision."

"Thank you Doc!"

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Further Reading

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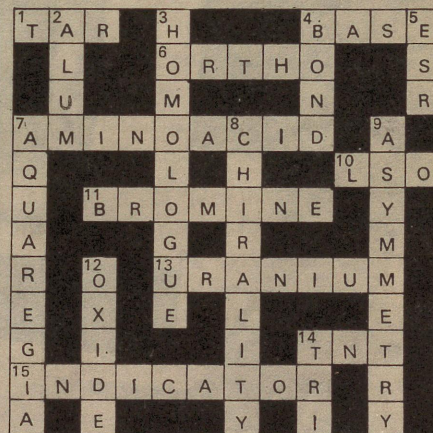
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Solution to Puzzle in Feb. 90

In The World Of BASIC-VII

IN an earlier part, the concept of variables was introduced. It was shown that there are two types of variables, viz., numeric and string variables. Now suppose in a program one or more of these variables were to keep on changing and the rest of the computations remain the same; is there a way of incorporating this? In short, can a statement be defined involving a variable whose value can be changed at our will? Similarly, in computer games where 'YES' or 'NO' answers have to be given, there may be a need to define a string variable which should be able to respond differently to either of these answers.

Input Statements

Such a statement by which a numeric or string variable can be changed is possible and the command word for that is INPUT. The

way an input statement is written is as follows:

```
10 INPUT N
```

(as usual there is one space between INPUT and line number and again between INPUT and the variable).

When the Program is run and reaches line 10, a question mark (?) appears which indicates the programmer that he has to type out the input value. Once he keys in the input value and presses RETURN, the computer proceeds to Program assuming the value of N that has been assigned. It is possible to avoid the question mark by writing the syntax in a slightly different way, viz.,

```
10 INPUT N " ", N
```

In this case, only the cursor appears and the value of N has to be keyed in. But it is advisable for beginners to write the INPUT statement in such a

way that the question mark appears.

The syntax of BASIC also allows one to combine a Print statement and the input in the same line; type the Print statement between strings (" ") first, and then put a semicolon and then type the actual variable:

```
10 INPUT "VALUE OF  
N= "; N
```

This appears as VALUE OF N=?

The Print statement between strings is called a prompt string as it prompts an operator to key in the value.

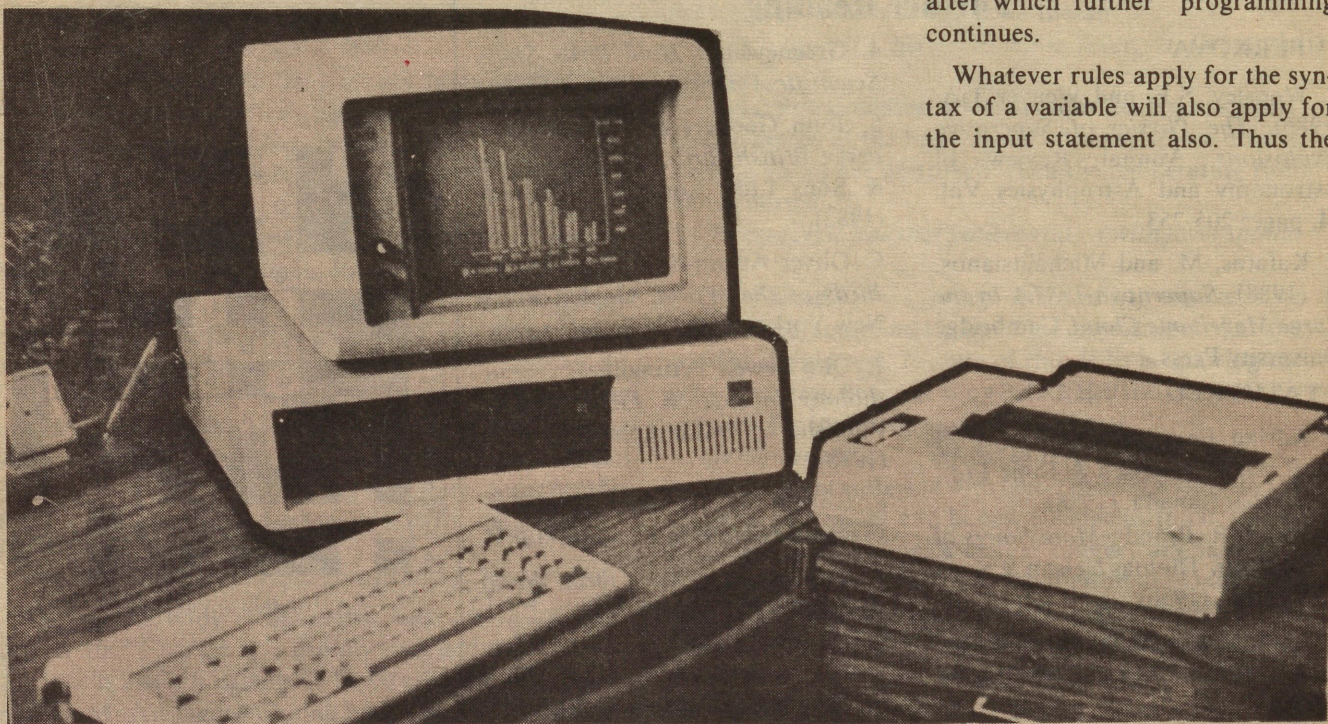
String Input

It is also possible to write an input statement involving string variables in a similar way:

```
10 INPUT A$
```

Here, also, as soon as the program reaches line 10, a question mark appears and the programmer has to input the 'string' and press Return after which further programming continues.

Whatever rules apply for the syntax of a variable will also apply for the input statement also. Thus the



COMPUTER

INPUT	OUTPUT	
10 REM NUMERIC INPUT		
20 A=25		
30 B=35		
40 PRINT A, B	25	25
50 PRINT		
60 INPUT N	?	10
70 PRINT (A+B)*N	600	
80 END		

Program 1. Numeric Input

INPUT	OUTPUT
10 REM STRING INPUT	
20 PRINT "COMPUTER GAMES WELCOMES YOU"	
30 INPUT N\$	
40 PRINT "HALLO!";N\$	
50 END	

Program 2. String Input

input statement can be framed as:

```
INPUT A INPUT AB INPUT A2
INPUT A$ INPUT AN$ INPUT A2$
```

An example involving numeric input is shown in Program 1. In the above Program, the values of A and B are defined in lines 20 and 30; these are then printed in line 40. Line 50 is a blank print statement meant for

inserting a gap. After 25 and 35 are printed, a ? appears, and if a value of 10 is typed and RETURN knob pressed, 600 appears as the result; therefore, in line 70, (A+B)*N is computed on the basis of N=10.

The reader should note a point here relating to INPUT. As long as the above Program is continued, wherever N appears the value of 10 will be assigned to N. However, on rerunning the above Program from the beginning, a question will again appear after 25 and 35 are printed; the programmer is free to assign any other value now. In short, the input statement processes a fresh data every time it is run but then this is the very purpose of a input statement. Program 2 illustrates a string input.

On running the above program, the statement in line 20, COMPUTER GAMES WELCOMES YOU appears first; it is followed by a ? in the next line. Now if say SWARUP is typed and RETURN pressed, the computer will respond with HALLO! SWARUP. Here also the computer will store SWARUP against N\$ and whenever N\$ appears it will respond

with SWARUP. But on re-running the Program, the string input can be changed again and the new string input will be taken.

It is easy to note that one need not confine to only one input statement, and a program can have as many inputs as necessary, the only condition being that different symbols should be used for each input variable. Different inputs can be given in the same line or different lines.

```
10 INPUT M
20 INPUT N
```

or alternatively

```
10 INPUT M, N
```

The difference in the two cases is that in the first case when a question mark(?) appears, the value for M has to be keyed in and RETURN pressed after which another ? will appear and the value for N has to be keyed in. In the second case, when a question mark (?) appears, both the values have to be keyed in, the first one for M and the second one for N (care should be taken to leave some space between the values).

In such cases where more than one input is needed, it is best for the beginner to write the input statement clearly by employing the prompt string (see Program 3). In the above, the strings appearing between the " " will be treated as a Prompt string and what will appear after the semi-colon as the actual input.

The most important use of an input statement is that a conditional GOTO can be given subsequently which serves a very useful purpose. This is illustrated in Program 4 (for the time being the reader need not bother about the statement in line 30 as it will be taken up in the next part).

INPUT	OUTPUT
10 REM INPUT STATEMENT	
20 INPUT "VALUE OF M="; M	VALUE OF M=? 10
30 INPUT "VALUE OF N="; N	VALUE OF N=? 5
40 PRINT	
50 PRINT "M* (M+N) = "; M* (M+N)	M* (M+N) = 50
60 END	

Programme 3. Writing Inputs in a Good way

INPUT	OUTPUT
10 REM MARKS TABULATION	
20 INPUT "MARKS ="; M	
30 IF M > 40 THEN GOTO 40	MARKS = ? 60
40 PRINT "CANDIDATE FAILED"	CANDIDATE PASSED
50 END	
60 PRINT "CANDIDATE PASSED"	MARKS = ? 30
70 END	CANDIDATE FAILED

Program 4. Conditional GOTO after INPUT

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(Continued from page 40)

contact to voltage source is not possible. A 4×4 cell ROM is shown in Fig. 7. To read the memory, the word line is connected to the voltage source which switches on the access transistor and thereby the bit line is connected to the source. Those transistors, which are made inoperable during manufacture, will not connect the bit line to the voltage source; they therefore indicate that a '0' or 'low' logic is stored.

Basically an ROM is a device having several input and output lines. Each combination of input values, is known as the address of the word. The combination of bits at the output is the 'word' that is read. The number of lines in the output is equal to the number of bits in the word. For n input lines there are 2^n distinct addresses possible. Thus a ROM physically realises a truth table or table of combinations. It will become clear from the following example:

In designing a ROM circuit that

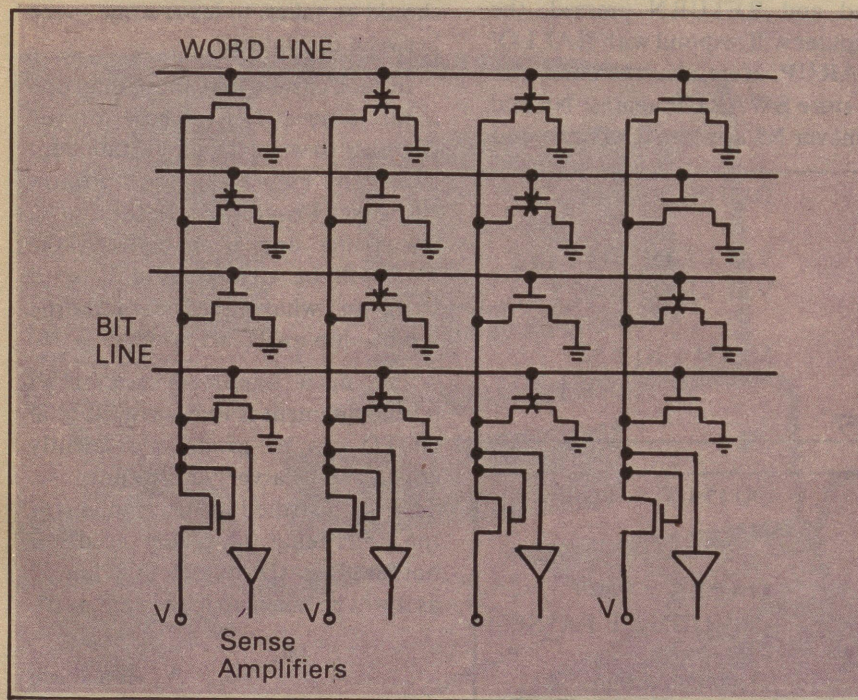


Fig. 7. $4 \text{ bits} \times 4 \text{ bits}$ MOS ROM, the transistors which are crossed are inoperable

Table 1. Truth table

S.No.	Inputs				Outputs				
	A ₂	A ₁	A ₀	B ₅	B ₄	B ₃	B ₂	B ₁	B ₀
1	0	0	0	0	0	0	0	0	0
2	0	0	1	0	0	0	0	0	1
3	0	1	0	0	0	0	1	0	0
4	0	1	1	0	0	1	0	0	1
5	1	0	0	0	1	0	0	0	0
6	1	0	1	0	1	1	0	0	1
7	1	1	0	1	0	0	1	0	0
8	1	1	1	1	1	0	0	0	1

gives the square of a 3-bit number, a truth table for the problem is first of all prepared. The truth table is a table of all possible combinations of logic variables (a logic variable can have two and only two distinct possible values: 1 and 0) showing the relation between the values of the variables and the result (see Table 1).

This problem is resolved with the help of a 3×6 ROM, i.e., it has 3 input lines and 6 output lines. Since the maximum decimal number that can

be represented using 3 bits is 7, its square is 49; which requires 6 bits for representation. Thus at least six output lines are necessary. For each specific values of inputs the outputs are fixed at the time of manufacturing as given by truth table.

The ROMs have been further improved so that there can now be programmed at the users' end. These memories are known as Programmable Read Only Memories (PROM) and Erasable Programmable Read Only Memories (EPROM). These two types of devices have greatly increased the usefulness and acceptability of ROMs. The PROM can be programmed only once by the user; then it works as ROM. The EPROM can be programmed again and again by erasing its contents with the help of an ultraviolet light eraser.

The trend as far as the main memory of a computer is concerned is to use semiconductor RAMs. For large storage capacity requirements magnetic memories are being used, but may be replaced soon by optical memories.

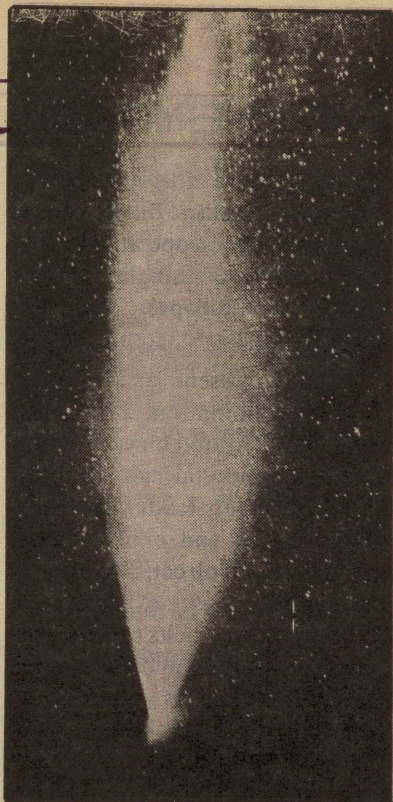
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Write Your Name On A Comet

EVERY clear moonless night amateur astronomer Kaoru Ikeya of Japan scanned the sky with a telescope built by himself. On January 8, 1963, he discovered the first comet of 1963, officially designated Comet Ikeya. Kaoru worked as a furniture designer and polisher in a piano factory, where his personal card read, "A steady fellow, reliable, quiet, middle school education only, no hobbies, lacks ambition and initiative."

But after the discovery of the comet, a spate of publicity greeted him. His house was invaded by press photographers. He was led before the TV cameras and radio network. He received nearly 700 letters seeking advice and was awarded a gold medal by the Tokyo Observatory. A film "Watching the stars" was made on his life to be shown to school and college students. His profile now reads, "Self-taught 19-year-old amateur astronomer Kaoru Ikeya, using a home made reflector telescope at a cost of Rs. 200 only, has discovered a new comet."

Since then Ikeya has made many other discoveries. In July 1964, working with a new and improved telescope, again built by himself, he spotted another comet. And in September 1965, he discovered his third, now known as Ikeya-Seki comet. This comet stirred global excitement with its unusually close approach to the sun. The comet was also spotted by another amateur astronomer, Tsutomu Seki, at the same time as Ikeya did, and so it was named Ikeya-Seki comet. Seki watched the sky from the city of Kochi, some 385 km away



Comet Seki

from Ikeya's town.

Ikeya neither sought nor was offered any promotion. But in the first 22 years of his life, he wrote his name across the sky three times!

PELTIER, who discovered comets in 1925, 1930, 1932, 1933 and the famous Peltier's comet in 1936, was a furniture designer. On moonless nights, he worked hard with his telescope and established his reputation as America's greatest amateur astronomer. But to buy his first telescope, Peltier picked strawberries. He was awarded the honorary degree of D.Sc. by the local university. The honour was showered on a boy who designed furniture and picked strawberries in his spare time! Sheer persistence and hard work helped him to write his name across the sky. The late Venu Bappu, sometime Director of the Indian Institute of Astrophysics, Bangalore, had also discovered a comet. Bappu is no more, but the comet will be remembered as Bappu's comet.

The first amateur astronomer to

observe the sky and bring its contents into some order was William Herschel. As he could not afford to buy a telescope, he started—as many amateurs do today—by making one from a tube and a few lenses. He was not only a gifted optician but also an expert observer. Helped by his sister Caroline, he made a chart of the sky in 1774 and worked persistently until his death in 1822. By this time, he had not only charted thousands of objects in the sky but had officially recorded and named Uranus, the planet beyond Saturn. To every amateur astronomer, Herschel stands as a model. His best telescope was a reflecting type, 102 cm in diameter. This is very large even by today's standards.

Do you want to become an amateur astronomer and write your name across the sky? The first step is to learn your way among 50 or so star groups or constellations visible from Indian latitudes. After studying the star charts published in newspapers and magazines like *Science Reporter*, identify the Big Dipper, Orion, Cassiopeia and some other constellations and work out the positions of others in relation to them. Soon, the initial chaos of the sky will fall into recognizable patterns.

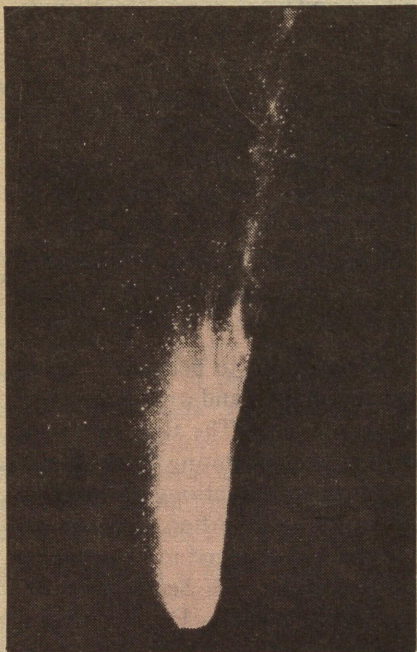
BUY a telescope or preferably make one for yourself. The hobby workshop at Nehru Planetarium at Bombay caters to the enthusiastic amateurs who wish to build their own telescopes. Pay a visit, if you are living at Bombay or a nearby town. It will be very rewarding. Telescopes made in India and costing a few hundred rupees are also available. Take some help and guidance from a professional astronomer. Join an Amateur Astronomers' Association.

Professional astronomers do not always look directly at the sky but use photography for their research

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work. The amateurs have therefore a good chance of spotting anything as obvious as a new star, exploding nova and comets. They can also watch variable stars for brightness.

The most spectacular field of observation for amateurs is the search for new comets. These huge



Comet Halley

clouds of gas and dust/ice particles revolve around the sun in highly elongated orbits, sometimes taking hundreds of years for one revolution. When far away from the sun, a comet is too faint to be seen, but it brightens as it approaches the sun and may even develop a spectacular tail. Because there is no way of knowing where and when comets will appear, everyone has an equal chance in comet hunting—a matter of patiently scanning the sky until a tell-tale hazy gleam is sighted.

Many comets have been discovered by fluke. In 1963, when Michael Candy, a professional astronomer, spotted a comet, he was testing a new telescope through his bedroom window. Another astronomer from New Zealand spent months searching for

a comet. He gave it up in order to observe variable stars. But no sooner he pointed his telescope at a star, he saw a new comet shining in the field of view of his telescope!

TRY to get a telescope as a birthday present or a gift for success in examination. The cost is same as that of a good bicycle. With a simple telescope you can study the Moon and planets from your backyard or terrace and explore lunar craters and rills. You can also observe the moon-like phases of Venus and Mercury, the cloud belts of Jupiter or the rings of Saturn and their satellites. Under dark skies you will have at your fingertips the vast star-clouds of the Milky Way, hundreds of globular and galactic star-clusters, scores of diffuse and planetary nebulae.

Many useful accessories for taking photographs with the help of a single lens reflex camera and auto drive to compensate for earth's motion are also available. They can be bought subsequently from your pocket money, as you improve your skills and knowledge of astronomy and gain some experience in sky watching. You can take photographs of the

eclipses of the sun and the moon. Sunspots and transits of planets like Venus and Mercury across the sun. Remarkable star clouds of the Milky Way, comet tails, meteor showers and whole constellations can be captured on the film. In the day it can be used for telephotography of birds.

Metropolitan cities like Bombay, Delhi, Calcutta and Madras are not the ideal places for amateur astronomers due to too much smoke, dust and haze caused by city lights. The best places are small towns and hill stations. Take your telescope with you when you visit your folks in small towns and hill stations or go on a holiday to beaches and summer resorts.

As you grow in age you may like to pursue astronomy in the college and university. Many universities offer graduate and post-graduate degrees in astronomy. Inter-University Centre for Astronomy and Astrophysics (IUCAA) has already been established at Pune.

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Repunit Numbers

A number whose digits are all units (i.e. consisting solely of digit 1) is called a 'Repunit number'. Repunit is a short form for 'repeated unit' as given by A.H. Beiler. So the numbers 1, 11, 111, ... etc. are all repunit numbers. If a repunit number is denoted by R_n , where n is the number of units, then such numbers can be represented by the following equation.

$$R_n = 10^{n-1} + 10^{n-2} + \dots + 10^2 + 10 + 1$$
$$\text{or } R_n = \frac{10^n - 1}{9} \quad \dots(i)$$

So, for $n = 1, 2, 3, \dots$ Equation (i) gives $R_1=1, R_2=11, R_3=111$, etc.

Repunit Primes

Repunit numbers which are also primes are called "Repunit primes". It has been a subject of great curiosity to find factors of repunit numbers. Only five repunit numbers have yet been found to yield primes and these five repunit primes are $R_2, R_{19}, R_{23}, R_{317}, R_{1031}$. The largest known repunit prime R_{1031} , consists of '1' repeated 1031 times and was discovered by Prof. H.C. Williams and others in

FOR THE YOUNG

1985 at University of Manitoba, Canada. For a repunit number R_n to be prime, n must be prime because if n is composite then $R_n = \frac{10^n - 1}{9}$ is

always composite, but if n is prime then $R_n = \frac{10^n - 1}{9}$ may be prime or 9 composite. For a

repunit number R_n to be prime, it is necessary (but not sufficient) condition that n must be prime.

It has been found that except five repunit primes stated above, all other repunits are composite numbers for $n \leq 9973$.

Repunit Numbers as Difference of Two Squares

Repunit numbers can be expressed as difference of two squares in a very interesting pattern given below:--

$$\begin{aligned} 6^2 - 5^2 &= 11 \\ 56^2 - 55^2 &= 111 \\ 556^2 - 555^2 &= 1111 \\ 5556^2 - 5555^2 &= 11111, \text{ and so on} \end{aligned}$$

The above result can be derived as follows:

All repunit numbers 11, 111, 1111, ... etc., are odd numbers and every odd number can be expressed as the difference of two squares in at least one way. So,

$$\begin{aligned} X^2 - Y^2 &= R_n \\ \text{or } (X + Y)(X - Y) &= R_n - 1 \\ \text{or } X + Y = R_n, X - Y &= 1 \\ \text{or } X = \frac{R_n + 1}{2}, Y &= \frac{R_n - 1}{2} \end{aligned}$$

Substituting $R_n = \frac{10^n - 1}{9}$ in the above equations, we get

$$X = \frac{10^n - 8}{18}, Y = \frac{10^n - 10}{18}$$

Leaving aside the trivial case of $n=1$, it is found that for

$$\begin{aligned} n=2: x &= 6, Y = 5, R_n = 11 \text{ so } 6^2 - 5^2 = 11 \\ n=3: x &= 56, Y = 55, R_n = 111 \text{ so } 56^2 - 55^2 = 111, \text{ and so on.} \end{aligned}$$

So, all repunit numbers can be expressed as difference of two squares in at least one way.

Note that all repunit primes can be expressed as difference of two squares only in one way, while other repunit numbers greater than 1 can be expressed as difference of two squares in more than one way. For example,

$$R_3 = 111 = 37.3; 111 = 56^2 - 55^2 = 20^2 - 17^2$$

$$R_4 = 1111 = 11.101; 1111 = 556^2 - 555^2 = 56^2 - 45^2 \text{ and so on.}$$

Repunit Square Pairs

A pair of square numbers in which one of the square is obtained by increasing each digit of the other square by unity can be termed as "repunit square pair". For example, (25, 36) is one such pair, as increasing each digit of 25 by unity, 36 is obtained which is also square. Hence the pair (25, 36) can be termed as repunit square pair. Some of the other examples of repunit square pairs are (2025, 3136), (13225, 24336), (4862025, 5973136), etc.

If a repunit square pair (RSP) is denoted by (X^2, Y^2) , then $Y^2 - X^2 = R$, where R is a repunit number of same number of digits as X^2 and Y^2 . If a repunit number R consists of even number of digits, then the value of X and Y can be easily obtained as follows:

$$\begin{aligned} R_n &= 111 \dots \text{ (upto } n \text{ times)} \quad \text{and} \\ R_{2n} &= 111 \dots \text{ (upto } 2n \text{ times).} \end{aligned}$$

$$\begin{aligned} \text{So, } R_2 &= 11 = 1.11 = R_1 (10^1 + 1) \\ R_4 &= 1111 = 11.101 = R_2 (10^2 + 1) \\ R_6 &= 111111 = 111.1001 = R_3 (10^3 + 1) \\ \text{and so on.} \end{aligned}$$

$$\text{So } R_{2n} = R_n(10^n + 1)$$

For a repunit square pair (X^2, Y^2) ,

$$Y^2 - X^2 = R_{2n}, \text{ where } R_{2n} \text{ is repunit number of } 2n \text{ digits.}$$

$$\rightarrow (Y - X)(Y + X) = R_n(10^n + 1)$$

$$\rightarrow Y - X = R_n, Y + X = 10^n + 1$$

$$\rightarrow Y = \frac{10^n + 1 + R_n}{2}$$

$$X = \frac{10^n + 1 - R_n}{2}$$

$$\text{For } n=1, R_n = 1, R_{2n} = 11;$$

$$\text{So } X = \frac{10^1 + 1 - 1}{2} = 5$$

$$\text{and } Y = \frac{10^1 + 1 + 1}{2} = 6$$

Similarly, for $n=2, R_{2n} = 1111, X = 45$ and $Y = 56$.

In general for $R_{2n} = 111 \dots (2n \text{ digits})$, $X = 4 \dots 45(n \text{ digits})$, $Y = 5 \dots 56(n \text{ digits})$

The above is true only if the repunit number R is having even number of digits.

If a repunit number R consists of odd number of digits, then the value of X and Y depends on the factors of repunit numbers.

For example:

$$R_5 = 11111 = 41.271 \text{ gives RSP as } (115^2, 156^2)$$

$$R_7 = 1111111 = 239.4649 \text{ gives RSP as } (2205^2, 2444^2)$$

$$R_{11} = 11111111111 = 21649.513239 \text{ gives RSP as } (267444^2, 245795^2)$$

Interestingly, corresponding to every repunit number of even number of digits, there exists a repunit square pair; however, it is not so if the repunit number consists of odd number of digits.

Palindromes

Square of repunit numbers R_n , i.e., 1, 11, 111, ... etc., produce palindromic squares when $n \leq 9$

$$1^2 = 1$$

$$11^2 = 121$$

$$111^2 = 12321$$

$$111111111^2 = 12345678987654321$$

If $n \geq 10$, then square of repunit numbers does not produce palindromic squares, e.g., $R_{10}^2 = 1111111111^2 = 1234567900987654321$ which is not a palindromic number.

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The Head Quarters

STANDING beneath a starlit sky, gazing at the twinkling wonders above, one is struck by a sense of awe. A feeling of oneness with the void above is mixed with the realization of the insignificance of human life. The fleeting timelessness experienced sharply focuses the limits of our own life spans. These thoughts that cross our mind sometime or the other are probably unique to our species. We seem to be the only ones living through a stretch of time, knowing well in advance that it is limited. The knowledge, that death is predestined and is the ultimate truth, is probably not shared with other living beings on earth. That surely makes us special. The fact that we are not here for good, makes us seek within ourselves and beyond a purpose for our individual life. A new dimension is added to mere survival! And one wonders whether it is this insight that has made us what we are today. Each one of us is a thinker, philosopher, explorer, learner and teacher in one's own small way learning from the ages begone—like no other living form can—endowed with a special form of communication that breaks the barriers of time—language. Such unique faculties have been acquired through the painfully prolonged process of evolution. Their emergence is a miracle in itself!

Strategies of survival of life on earth are diverse and a variety of sizes, shapes, life styles have developed. Most of the life forms find a silent niche for themselves—slowly adapting to an ever changing environment. The unpredictable harshness of surroundings often take the toll—strategies fail, leading to

extinctions. With the arrival of *Homo sapiens* a new strategy is at test! Life is more than a matter of chance—it is a conscious effort. Environment that cannot be adapted to can be purposefully changed—if not totally, substantially. And these impositions on our surroundings have in turn evolved us continuously! With time, human colour, stature, size and form seem to play less of a role for survival. The varied functions of our brain, its plasticity and adaptability appears to offer an edge over other forms of life on earth. Our nervous system has come a long way—still carrying functional relics of our remote past. We have it all within us—nerve nets as simple as that of primitive organisms like the *Hydra*, 'ganglionic' collection of neurons like that of invertebrates, brain stem like that of early vertebrates and of course a little more! The fundamental unit has remained, the same, throughout the march of evolution. An assemblage of 'neurons'. What has changed is the outlay—the map of this neuronal assembly. Functional concentration of these cellular units, the neuron, have made up the structure we call the brain. The brain has turned out to be the most versatile organ in our evolutionary process—ever changing. Over the epochs some functions have been added, some have been deleted, some have amplified, while others have declined. Changes have taken gross anatomical forms or have been subtle chemical ones. And here we are today, with a map of the brain, fairly exclusive but with a lot in common with all others before us!

In very early vertebrates the fundamental blue print of the brain was

laid. It was a very simple one—the 'fore brain' to receive information about how the surroundings smell, the 'mid brain' to help 'see' and the hind brain to perceive sound. In addition, the hind brain also helped in balancing and kept an eye on the parts of the animal that filled the body cavity. The signals from the sensory sources were brought in through the spinal cord or just directly into the brain. Bundles of nerves bringing in the signals organized themselves as 'sensory tracts' while bundles that furnished signals back, as a response to stimuli, formed the 'motor tracts'. Inevitably, a majority of motor tracts ultimately ran into muscles. Where the sensory and motor pathways met, a specific organizational unit of the brain played a role for their integration. The mid brain emerged as the major site of this liaison. As vertebrates evolved, complexities were added to this basic lay out. The three major parts of the brain—fore brain, mid brain and hind brain—were functionally and structurally enriched to variable extent. The present versatile brain we have is a net result of some of these overwhelming modifications.

Travelling through the terrain of our brain is as exciting as astral travel and is in no way simple! Our limitations are obvious. As David Hubel, neurobiologist from Harvard puts it—'Can a brain understand the brain?'. With all our modest means we have made some commendable attempts! The mazes of the brain have been entered through several doors. Studies have been carried out at various levels. At the anatomical level—well within the reach of the

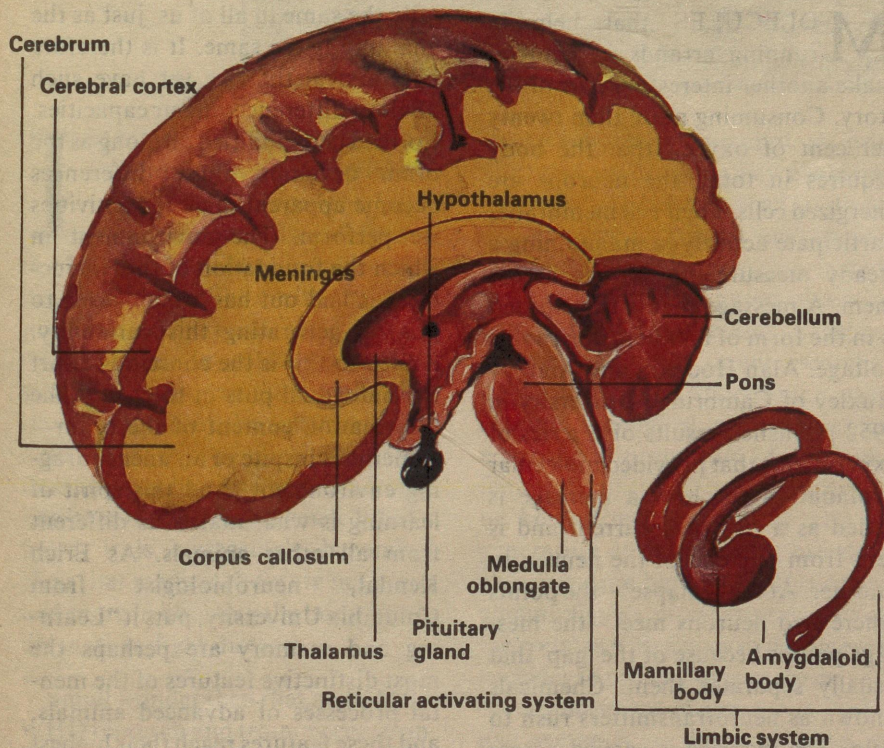
resolution of our eyes. At cellular level—the level introduced by Leeuwenhoek—with the discovery of the microscope. At the molecular level—the frontiers which we tread at present! At each of these levels of organization, pieces of jigsaw are formed—some meaningful, others yet waiting to fit into the picture. Together they bring forth a hazy story of how we are managing to run our body functions smoothly, like any other animal. In addition we are able to do a little more—remember, speak, think and judge. It is these higher functions of the brain that are difficult to study—as we have no animal model to work on.

cortex—the part rich in neuronal cells. This is the ‘neo cortex’ formed from the roof of the fore brain of the primitive blue print. It is the part that makes us different from other animals—it stores our memories, records and perceptions and performs the other special functions our brain is endowed with. Both the halves—the hemispheres of the cerebrum—are the store houses of all that we have learned. Our skills, oral and muscular, are engraved in this part. Areas that help us hear, see, speak, remember and perform delicate muscle movements can be mapped in the grey mass. The two halves of the cerebrum, though

ganglia’—the part that helps in gross body movement.

The cerebral office, performing the ever so important functions, need to be supplied with information continuously. The inputs need to be sorted and reported to the appropriate sub-region. This task is done by the ‘thalamus’. Fused to the base of the cerebrum, the thalamus relays signals coming up from the brain stem and spinal code. The thalamus has a partner, the hypothalamus. Modest in size, the hypothalamus is very much in control of the internal body functions. Its ability to conduct the orchestra of hormones by sending forth ‘releasing factors’ is impressive. For the cerebral functions to be appropriately executed the fine tuning of the body by hypothalamic modulation of hormones is imperative!

With all our so called ‘higher functions’ in full swing, we at times land up being a bundle of nerves. Emotions overtake all other aspects of perceptions. A complex churning of memories, emotions and perceptions makes us behave as we do. Amygdala, hand-in-glove with the hypothalamus, is the part that is responsible for mixing emotions with perceptions and memories. Forming the ‘limbic system’ with amygdala is the hippocampus—a region that helps store memories for long times. Forming the bordering areas of the fore brain, the limbic system cuts the regions performing more ‘human functions’ from the regions that perform fundamental ‘animal functions’. This region performing the very basic functions is the brain stem—evolved from the mid brain and the hind brain of the primitive vertebrate brain. Nerve tracts run through the stem upto the thalamus. Signals to muscles for performing every mundane function of the body run down to the spinal cord through the brain



WEIGHING about 1,300 grams, we have a brain far bigger in size than that expected of a mammal of our weight. The jelly-like dirty grey matter that forms more than three quarters of our brain is the cerebrum. Furrowed with deep folds, halved by a central fissure the entire layer of the cerebrum forms the

asymmetrical and independent, are in league with each other. They exchange notes and share information continuously. Millions of nerve tracts cross over from either side—named by anatomists as ‘the corpus callosum’ and ‘the anterior commissure’. Also deep inside is an aggregate of neuronal cells—the basal

THE BRAIN

stem. Centres for controlling movement of our eye muscles, for craning the neck or totally turning around are lodged in special pools of neurons in the 'mid brain' and 'the pons' and are laid out within as a network of neuronal cell pools known as 'reticular formation'. Part of this cell pool governs our stature and posture. The co-ordinator of a majority of our responses is the cerebellum. Our erect, agile walk, our equilibrium, the subtle phasing of our movements as required for certain actions—all the physical characteristics that have helped us evolve are supplied by the brain stem. Running down from the brain stem, secure within the bony vertebral column is the spinal cord—the extension that at times performs on its own.

No better anatomical architectural plan seems possible than the one we have acquired through the ages. Truly democratic, each part of the brain has its say—none can be said to be more important than the other. Co-operation, co-ordination and co-existence is the theme—successful survival and creativity has been the result. At the cellular level each anatomical structure comes with a difference, but the thread remains the same. A single cell type—the neuron—with a few accessories run the show. Shaped like tiny stars with a tail called axon, the neurons make up the nerve fiber. Packing neurons up in bundles and supporting its activities in every possible form are a group of 'glial cells'. For years the neurons remained beyond the reach of cytologists—more so because of their peculiar shape that spanned several layers of the tissue. The year 1875 brought a breakthrough. The Italian neuroanatomist Camillo Golgi devised a method for staining single neurons. The 'Golgi technique' was exploited to its maximum by Santiago Ramon Y Cajal—who virtually studied every part of the ner-

vous system. The Nobel prize was shared by these two contemporary stalwarts in 1906 for pinning down the elusive neurons. The intricate links that connect one neuron to another were, however, still more difficult to pick up. Walle J.H. Nauter in 1950 developed a microtechnique for this. With concomitant developments in biochemistry and biophysical technology techniques like autoradiography, immunohistochemistry and the latest, positron emission tomography have helped trace the neuronal by-lanes. The task is vast as millions of neurons need to be scored before we can really get a complete cellular map!

MOLECULES that help in running errands in neurons make another interesting part of the story. Consuming more than twenty per cent of oxygen that the body requires in total, the neurons are energized cells. Their cell membranes participate actively in maintaining a steady measureable voltage across them. A message that is transmitted is in the form of an alteration in this voltage. Alan Hodgkin and Andrew Huxley of Cambridge University in 1952 published results of a series of experiments that provided molecular explanation for how a message is coded as an electrical current and is sent from one end of the neuron to another. At the 'synapse'—the points where two neurons meet—the message pauses because of the 'gap' that usually separates them. Chemicals known as neurotransmitters rush to help. The message is carried across these chemical messengers generated by the neurons themselves: The brain has no less than thirty types of such messengers. Some types of messenger molecules, the excitatory neurotransmitters, specialize in faithfully transmitting the signals, while others, the inhibitory ones help in creating a block. The synaptic junctions are the tiny courtrooms where chemi-

cal jurisprudence is used—messages arriving from various sources are reviewed before transmitting. The chemical messengers have a major role to play in these decisions. Generated in a well defined pattern within each group of neurons, these messenger molecules give the parts of the brain their typical chemical character. This, in turn, helps each part to play its unique functional role. Even the higher functions of the brain can be decoded down to manipulations of these chemicals within the brain!

The multitude of messenger molecules, the form of electrical impulses carried, the tracts through which these messengers run, are fundamentally the same in all of us, just as the anatomy is the same. It is therefore paradoxical that we yet have such obvious differences in our capacities. Formed and modified all along as the brain develops, these differences become apparent in all the activities we perform. The environment in which the foundation of these structures is laid out has a major role to play in generating this variability. Added to this is the conscious effort the individual puts in to change the information content of the brain—sometimes inspite of an unencouraging environment. And this spirit of learning is what makes us different from all other animals. As Erich Kendal, neurobiologist from Columbia University, puts it "Learning and memory are perhaps the most distinctive features of the mental processes of advanced animals, and these features reach their highest form in man. In fact, human beings are what they are in good measure because of what they have learned!" And about these higher functions of the brain we have yet a lot more to know and learn!

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National Institute of Immunology

A mere toddler among the nation's research institutes, the National Institute of Immunology in New Delhi has achieved a measure of success of which any scientific enterprise could be justifiably proud. A range of antifertility vaccines applicable to humans as well as animals, techniques of embryo splitting as well as transfer to improve the quality of livestock, and simple but sensitive kits to detect pregnancy and tropical diseases like amoebiasis, leprosy and hepatitis have all left the drawing board for field trials or applications

IMMUNOLOGY is both an ancient craft and a modern science. Long before the English physician Edward Jenner in 1780s is said to have immunized a boy against smallpox with the cowpox vesicle from a milkmaid, Asians were known to inoculate people with smallpox to protect them from later severe attacks of the infectious disease. Yet it is only since 1940s that immunology has emerged as a front-line inter-disciplinary science. What's more, it is increasingly becoming clear that medicine's future lies more and more in boosting the body's own defences to fight diseases.

Small wonder then that an ICMR-WHO research and training centre in immunology at the All-India Institute of Medical Sciences should have developed into a full-fledged research institute in 1981, as a registered society. The Institute, which came up on the Jawaharlal Nehru University campus, was formally inaugurated on 6 October, 1986.

Immunological research pursued by the scientists at NII is both exploratory and applicatory. Not only

does research in immunology provide answers to some key problems of biology, it can also lead to direct applications in animal and human health. Principally mission-oriented, NII's research encompasses the entire gamut of RDD—research, development and delivery. Current researches could be grouped under four areas: (1) immunological approaches for control and promotion of male and female fertility; (2) standardization of known technologies as well as generation of new ones for breeding elite cows and buffaloes; (3) study of communicable diseases prevalent in the country with a view to developing vaccines to prevent or cure them; and (4) development of simple yet sensitive methods to diagnose diseases specific to the country. Whatever the area of research, what is of utmost concern to NII is the national relevance of the problem.

ONE of NII's vaccines which has hit the headlines in the national and international press is 'Tulsar'. This is the trade name for the single injection method of sterilizing or castrating male animals. This, in fact, is

two procedures, one leading to sterilization without affecting the animal's virility (or libido, as psychologists would call), and the other resulting in loss of virility. According to the NII's director Dr. G.P. Talwar, the technique is the first of its kind developed anywhere in the world. The technique is applicable to all mammals—dogs, tomcats, he-goats, bulls, rams and the like.

The vaccine is based on BCG (Bacillus Calmette-Guérin), which is used for preventing tuberculosis, and elicits an immune response at the site of the sperm production.

The vaccine is also available in a reversible mode, though for animals permanent sterilization is preferred. It costs no more than a rupee to sterilize a bull, and is a civilized procedure for castrating bulls, without the cruelty and pain associated with the traditional Burdizzo castrator.

Sterilizing bulls is not an end itself. The ultimate aim is to improve the genetic stock of animals, cows and buffaloes in particular. India's artificial insemination programme has not been able to make much headway

MODERN TEMPLES

because scrub bulls act too fast to frustrate attempts to introduce frozen semen, which in turn does not always arrive in time from semen banks. The sterilized bulls with virility intact have a role to play here, for they can still function as teaser bulls in detecting cows in heat, much better than vets. Furthermore, by curbing the scrub bull menace, the vaccine could prove a boon in controlling the spread of weak genetic livestock and, at the same time, help develop superior-quality cattle, especially high milk yielding varieties.

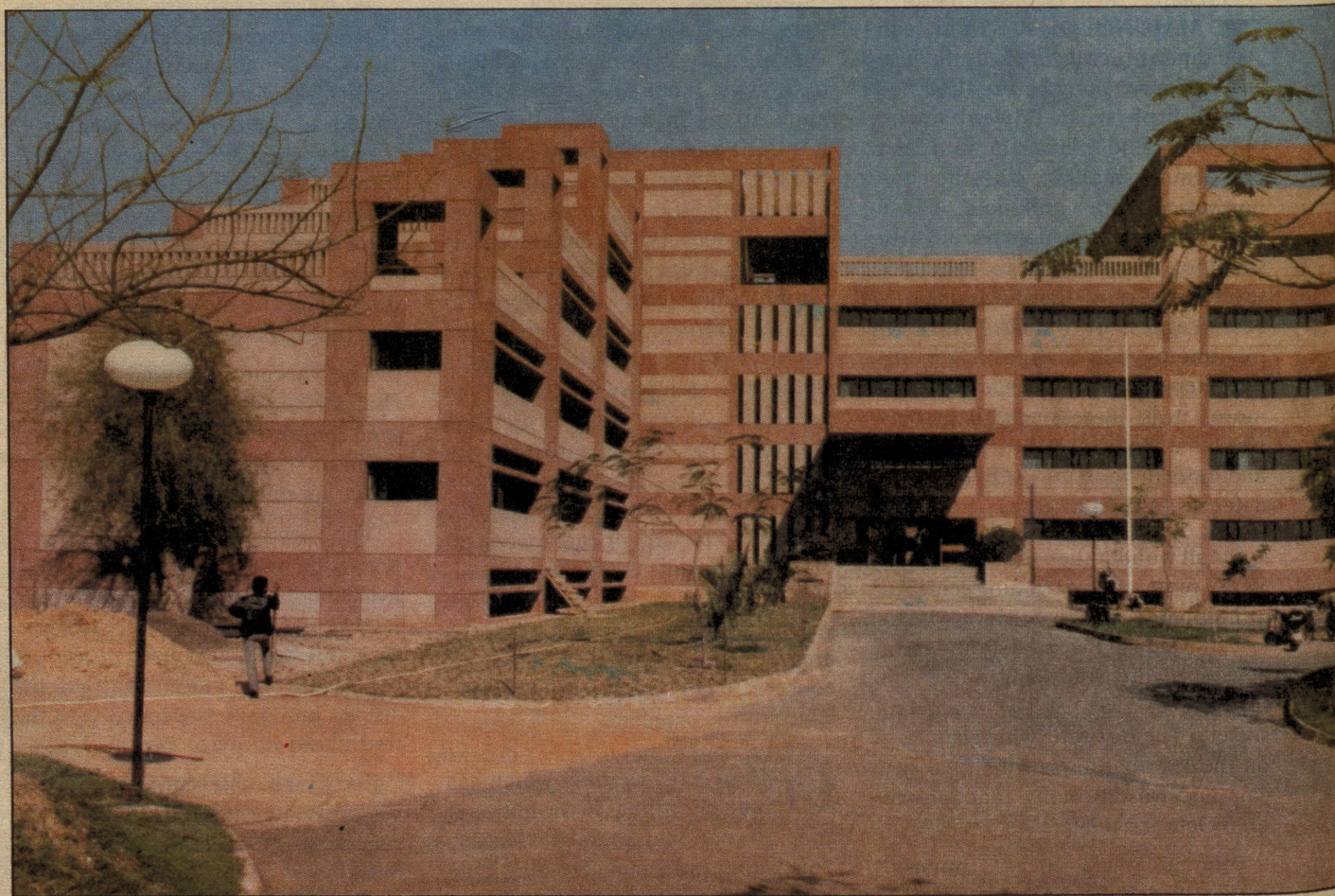
The vaccine has undergone successful field trials at Bhoosali, a village in Haryana. It has also been evaluated by a number of national laboratories, namely, the National

Dairy Research Institute, Karnal; Indian Veterinary Research Institute, Izatnagar; Indian Agricultural Research Institute, New Delhi; and the National Dairy Development Board, Anand, and found to be 100% effective without any serious side-effects. The package of techniques has been passed on to a public sector company, Karnataka Antibiotics & Pharmaceuticals Ltd., for manufacture and distribution.

NII's major thrust has been, however, on development of anti-fertility vaccines for use in humans—male and female. This is because a birth control vaccine has many advantages over the conventional contraceptives : fertility control

for longer durations, obviating day-to-day intake, thus conferring freedom from risks of user-failure, and, more importantly, reversibility. Another plus point of the vaccines is that they would be more suited to the heterogeneous populations comprising as they do disparate socio-economic groups of diverse cultural backgrounds.

Three candidate vaccines, one conceived as far back as 1974, and two improved versions, are completing phase I clinical trials. These vaccines are technically known as anti-hCG vaccines because they are directed against the human pregnancy hormone, called human chorionic gonadotropin (or hCG). The principle underlying these vaccines is to induce



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Male calf born from non-surgical split embryo transfer, and its surrogate mother. The embryo was obtained from a 17-year-old lame retired breeder

antibodies which can bind to hCG and render it biologically inactive.

The anti-hCG vaccine which uses a subunit of hCG—the β -subunit linked to tetanus toxoid (with the biochemical shorthand β -hCG-TT)—has undergone clinical trials in women volunteers in India (five centres) and three other countries, namely Finland, Chile and Dominican Republic.

In the not-too-distance future are in sight two more vaccines, one against gonadotropin-releasing hormone (GnRH) and another against sperm antigen.

Human anti-fertility vaccines aside, NII has made a genetically manipulated vaccine against rabies, known as vaccinia rabies glycoprotein vaccine (VRGP). Mice immunized with VRGP and subsequently challenged with virulent rabies virus

were 100% protected. The lab trials would be extended to dogs. The biggest advantage of the genetic engineering approach is its low cost as well as easy delivery, perhaps even through the oral route. Conventional antirabies vaccines are made from infected animals brains or through tissue culture, and these are administered through injections which are extremely painful courses.

Another anti-fertility vaccine, designated as anti-LHRH (leutenizing hormone releasing hormone) vaccine is under development. Linked to diphtheria toxoid as carrier, the vaccine brought about drastic reduction of the prostate in rats and monkeys after immunization. Vaccines of this group are expected to find application in treating precocious puberty and hormone-dependent carcinoma of the prostate and breast cancer.

An anti-leprosy vaccine based on *Mycobacterium w.* is under clinical trials in hospitals. It is being given to multibacillary leprosy patients. Patients who received immunotherapy with this vaccine in combination with chemotherapy responded better than those who received chemotherapy alone. An advantage of this vaccine is that it also affords protection against tuberculosis.

In one of the current projects aimed at characterizing the virus causing a form of hepatitis widely prevalent in Northern India, an initial breakthrough has been made. This form of hepatitis is designated as non-A, non-B for the reason that it belongs neither to A-form nor to B-form of the disease. Here the Institute's success lies in developing a monkey model of the disease which simulates the features of the human disease. The model offers the

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researchers a source for purifying the virus and characterizing it.

DEVELOPING anti-fertility vaccines to check proliferation of genetically low-grade livestock is not the only solution to improving the animal wealth of the country. Some positive approaches are also called for. Here the Institute is making its thrust through embryo biotechnology. Work in this field is done in collaboration with the National Dairy Development Board and the Indian Agricultural Research Institute. NII is also the lead laboratory in the country for embryo transfer, cloning and sexing; it functions as a national repository of frozen embryos on behalf of the Department of Biotechnology.

The NII's scientists have succeeded in what is considered to be the first instance in India of producing a calf by non-surgical embryo transfer. Another first-ever in the country, standing to the credit of NII is using low-milk-yielding local cows for delivering a 100% Holstein-Friesian female calf. The embryo transfer technique enables the utilization of non-descript cows to act as surrogate mothers, and so earns their keep.

The Institute has also perfected techniques of splitting bovine embryos and succeeded in obtaining several pregnancies by transfer of split embryos. Deep-frozen embryos have been split after thawing and have led to pregnancies. The obvious advantage of embryo-splitting is the doubling of the yield of calves. The ET techniques are being extended to buffaloes, the mainstay of the Indian dairy industry.

Immunological and DNA probes are also being developed to decipher the sex of embryos before transfer. This is important in controlling the sex ratio of animals of economic value.

Two new lines of research in aquaculture, also exploiting embryo biotechnology, have been taken up. One of the projects aims at inducing off-season breeding of freshwater major Indian carps through hormones. Another aims at developing transgenic strains of fishes which can grow at a faster rate and have a better feed-conversion ratio. Here the growth hormone gene is injected into one-celled embryo. The cells of the transgenic fish, and so the offspring, carry the injected gene.

“Never in the history of human progress was there a better and cheaper method of preventing illness than immunization at its best.”

Jeffry Edsel

TIMELY diagnosis of diseases like typhoid and tuberculosis is a long-felt need in the country. Equally important it is to develop kits which can be handled by semi-skilled para-medical staff in the field. The Institute has developed a number of monoclonals against the different antigens of typhoid-causing bacteria (*Salmonella typhi*). A simple dipstick test developed using monoclonals can diagnose typhoid with a near 100% accuracy and is highly sensitive. A DNA probe developed recently is specific to *M. tuberculosis*.

Kits for detecting amoebiasis, leprosy and hepatitis have been developed.

The kit for detecting pregnancy has already been in field use. Two such kits have been licensed to Ranbaxy Laboratories Ltd.

What needs emphasis in the development of diagnostic kits is that these are based on frontier technology not yet available in the country.

THE Institute maintains an excellent experimental animal facility where genetically defined inbred

strains of laboratory mice and rats are bred and maintained under controlled environmental conditions

The Institute also maintains a primate research centre which houses rhesus monkeys, bonnet monkeys, langurs, baboons and marmosets.

A product development cell which the Institute has established recently facilitates the transition of diagnostic kits and vaccines to industry. The cell undertakes product stabilization, packaging, and process development.

NII also provides histocompatibility matching services to a number of hospitals in regard to organ transplantation.

NII services as a centre for training and manpower development in immunology. The Institute is recognized by WHO as a collaborating centre for training and research in immunology for India and South East Asia. It is also recognized as a node of the International Hybridoma Databank.

The Institute has collaborative programmes with a number of Indian laboratories as well as international bodies, such as the Centre for Biomedical Research and the International Committee for Contraception Research of the Population Council, New York, and Pasteur Institute, Paris.

On NII's future agenda of research would be AIDS, which may not immediately get as much priority as TB and like diseases. "When a programme for AIDS research is chalked out it would, however, be a comprehensive one, right from designing indigenous kits for detection to a complete study of the disease to its cure", says Dr. Talwar.

P.S. Shankar

139, Akash Darshan Apts

Mayur Vihar I

Delhi-110 092

National Awards

THE President of India this year honoured the following scientists, engineers and medicos for outstanding contributions in their respective fields by conferring on them the titles Padma Vibhushan, Padma Bhushan and Padma Shri.

Padma Vibhushan

Dr Avul Paker Jainulabdeen Abdul Kalam (Space and Missile Technology), Hyderabad and Dr Vallampodgai Srinivasa Rajdavan Arunachalam (Metallurgical and Technological Research), New Delhi.

Padma Bhushan

Dr Bal Krishna Goyal (Cardiology), Bombay; Prof. Bimal Kumar Bachhawat (Biochemistry), New



L.K. Doraiswamy

Delhi; Dr Laxmangudi Krishnamurthy Doraiswamy (Chemical Engineering), Pune; Dr Matur Ramaswamy Srinivasan (Nuclear Technology), Bombay; Dr Madumbai Seshachelu Narsimhan (Mathematics), Bombay; Dr Marthanda Varma Sankaran Valiathan (Cardiac Surgery), Trivandrum; Dr Mohammad Khalilullah (Cardiology), New Delhi.

Padma Shri

Dr Arutosh Datta (Gyc. surgery), Calcutta; Dr Ashok C. Sheriff (Ophthalmology), Bombay; Mr Jatish Chandra Bhattacharya (Space Technology), Hyderabad; Dr Madhav Gajanan Deo (Medical Research), Bombay; Dr M. Krishna Bhargava (Medicine), Bangalore; Mr Madhuvan Pillai Ramakrishna Kurup (Space Technology), Sriharikota, A.P.; Dr Noshir Hormasji Antia (Plastic Surgery), Bombay; Dr Pylore Krishnaier Rajgopalan (Medical Research), Pondicherry; Mr Ram Narain Agarwal (Space Technology), Hyderabad; Dr Shriniwas (Microbiology), New Delhi.

National Science Seminar

“**A**TOMIC energy—potentialities and hazards” was the theme of the latest National Science Seminar held on October 8, 1989 at the Visvesvaraya Industrial and Technological Museum, Bangalore, under the auspices of the National Council of Science Museums. In his keynote address to students and audience, C.V. Sundaram, Director, Indira Gandhi Center for Atomic Research, Kalpakkam, stressed the importance of atomic energy in fulfilling the rising energy demands of the country. Later, he also gave a lecture based on slide-show on the types of atomic reactors that have been conceived and commissioned in India by the research efforts of the Department of Atomic Energy. S. Varadarajan, Chairman of the Governing body of the National Council of Science Museums, took the Chair and conducted the proceedings of the seminar.

The debate on the theme of the seminar was keenly fought with the

participants giving their best with the support of charts, slides and other relevant visual materials. T.R. Satishchandran, Director, Institute for Social & Economic Change, addressed the students and gave away the awards to the winners. He emphasised that as non-conventional energy sources are still under developmental stage, atomic energy is likely to stay with us for a long time to come but precautions have to be taken regarding safety standards of reactors.

Although the final debate on the theme at the national level involved 32 students, the earlier contests were held at the taluk, district and state levels involving thousands of students throughout the country.

The winner of the debate this time was M. Manoj of Kottayam Raja's High School, Cannore, Kerala. He has bagged the National Council of Science Museum fellowship for one year. The other ten were the runner-sup. □

India Develops Beryllium Metal Production Technology

INDIA has become the second country in the world, besides the United States, to develop the technology for producing beryllium metal and its alloys which are indispensable for space programmes, and electrical and electronic industries. Scientists at the Bhabha Atomic Research Centre have set up a pilot plant to handle about 2 kg of beryllium to produce vacuum hot pressed (VAP) beryllium metal and copper-beryllium ingots.

The VHP beryllium produced is being supplied mainly to the Department of Space and to a limited extent to the Department of Atomic Energy for nuclear applications. Metal beryllium is considered vital for the space industry specially in navigational guidance systems of space vehicles, because of its lightness, high rigidity and dimensional stability. □

BOOKSHELF

RENEWABLE ENERGY by Maheshwar Dayal, *Konark Publishing Pvt. Ltd.* A-149, Main Vikas Marg, Delhi-110092, pp x + 244, Rs. 150.00

NOW renewable energy is no more new to the masses. People are well aware of biogas, improved chulhas, solar cookers, wind-mills, etc. There are however still some products, devices and systems such as alcohol fuels, petro fuels, gasifiers, photovoltaic cells, which have yet to be commercially manufactured. They are being accepted



very slowly because of easy availability of fossil fuels, and the lack of awareness of newer technologies of renewable energy sources, and so on. In our country, some books have been brought out on various facets of renewable energy. In most cases, they are available in technical language and in narrow areas like bio-energy, solar energy, wind energy, etc. The book under review covering an entire area of renewable energy in semi-technical language fills the information gap felt by everyone in India since the energy crisis of 1973.

The book is divided into three parts: bio-energy, solar energy, and other renewable energy sources, which are spread in 13 chapters. Part

I covers three chapters dealing with energy from biomass, biogas technology and cook-stoves. Part II highlights solar thermal energy and photovoltaics. Part III covers all other renewable energy sources, including economics, environment and transport in relation to renewable energy. The chapters on energy sources begin with a brief introduction on the history and principles of energy generation, equipment, devices and systems developed till now and then goes over to their prospects, potential and programmes underway in India. The text is explained with the help of simple figures, sketches, plates and tables containing necessary and latest data. Wherever necessary the economics of fuels and systems is given. The significant feature of the book is the explanation of current projects underway in India, their achievements and constraints and future programmes.

Although the author has tried to cover in brief the entire subject, some topics need more details. Part I on bio-energy lacks information on petrocrops, energy weeds and types of cook-stoves in India. Chapter 11 on "Renewable Energy for Transport" lacks information on liquid hydrocarbon fuels, seed oils as fuels and biogas, producer gas and sewage gas as fuels for transport, their road tests, present status and future programmes. The information on the availability of sunshine in India, had it been given, would have been a useful data for those using or willing to use solar energy. As some economic aspects have already been covered, Chapter 12 on "Economic Aspects of Renewable Energy Systems" could have been merged with other chapters. Units are not uniform; in most cases they are in Metric System but at some places they are in British System. On page 64, figure is presented as table. On page 186 and 197, the

description of NO_x is as (NO)_x. Apart from proof mistakes at one or two places, the book is neatly printed.

Looking at the overall perspective of the book, it is an excellent effort. The elegantly printed book is highly recommended to all institutional, sectional and even personal libraries concerned with energy in particular and other scientific, planning and administrative institutions in general.

P.D. Tyagi

HAZARDS OF BIOTECHNOLOGY : REAL OR IMAGINARY

Edited by: Anthony D. Dayan, Peter N. Campbell and Thomas H. Jukes. *Elsevier Science Publishers Ltd.*, Pp. 138, Price not mentioned.

BOOKS or articles written by scientists rarely address the common man as they are often loaded with technical jargon. In recent times, however, science has permeated so deep into the common man's daily life that it is no wonder he is becoming increasingly interested in at least some scientific applications. Biotechnology is one such area of science which is being widely followed by scientist and layman alike in the technologically developed western world as well as the traditional, developing eastern world. Many questions appear in the common man's mind regarding the hazards of the new technology and a book, which searchingly analyses its implications, is welcomed. The book under review is one such compendium of papers presented at "The Biological Council's symposium, Hazards of Biotechnology", held in London in 1987.

The symposium was opened by Thomas Jukes who also presented the introductory chapter of the book.

BOOKSHELF

In his paper Jukes cautioned the tendency towards exaggerating the novelty of biotechnology, which has long been in use especially in food industry and agriculture. He argued that due to sheer power of performance alone, biotechnological research should be encouraged and given its due recognition. Simon Levin of Cornell University, U.S.A., somewhat agreed with Jukes but demanded caution in the release of genetically altered organisms into the environment. Beringer also touched upon the same aspects and asked for rigorous assessment of the potential hazards on a case by case basis. Bulfield outlined the present state of research on genetic manipulation in laboratory and farm animals and the potential hazards involved therein. Edelman, in his paper, described the development of a new food "Mycoprotein" through the action of a fungus on starch. While Bobrow outlined the application of DNA probes for prenatal diagnosis, including the much-maligned amniocentesis and ultrasound, Zuckerman and Robertson dwelt in detail on the new approaches to the development of viral vaccines, especially hepatitis 'B' vaccine. Bryan-Finkle from Genetech gave an account of the new medicines from pharmaceutical industry and the enormous care which is exercised before a new drug is introduced into the market. Both he and Freestone from Wellcome laboratories convincingly argued that it is the drug which is to be critically tested and not the method of its manufacture alone. Legal aspects of biotechnology and problems concerned with patents are discussed at length by the lawyer Hugh Laddie.

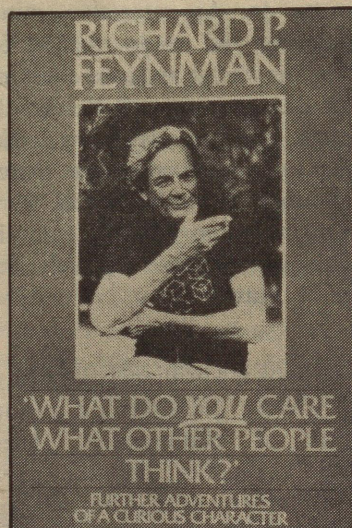
Scheibner and Bass from Germany and Ager and Nourish from the UK outlined the involvement of government in the control of gene transfer in the UK and the EEC. The last two papers by Joyce Tait of Open Uni-

versity and Dr. Vere of the London Hospital Medical College dealt with the public perception of the hazards of biotechnology and securing safety against such hazards.

Risk-related issues like Nuclear power, pesticides and biotechnology could provoke an adverse public response at the occurrence of the slightest mishap. The controversies generated within the scientific community also add to the problem. Against such a backdrop, this book provides a sensible assessment of a highly controversial subject like biotechnology and an interesting reading material for all those inquisitive and socio-ecologically aware minds in the community.

K.D.P. Rao

WHAT DO YOU CARE, WHAT OTHER PEOPLE THINK, Further Adventures of a Curious Character, By Richard P. Feynman, *Unwin Paperbacks* (Available from *Rupa & Co.*, 3831, Pataudi House Road, Delhi-110002), Pp. 255, £ 2.95.



THOSE who have read *Surely, You're Joking, Mr Feynman!* cannot forget the frank confessions of its author, Richard P. Feynman, a

Noble Laureate in physics. His off-the-shoulder style, his sense of humour, his naughtiness, his frank opinion on the development of science in the world, and of course his skirt-chasing activities—all make a deep impact on the reader's mind. His book is likely to be read, enjoyed, and his footsteps followed by several generations of physicists. It won't be surprising if the present generation of physicists take inspiration from his skirt-chasing activity believing it to be a mark of genius and get spoiled in the process! Indeed, the book is today a best-seller and is slowly not only drawing the attention of scientists from all other disciplines but also of the public at large. The book has also instantly made Feynman a lovable and likeable character all over the world and his fans would like to read about his further adventures, ideas in science and opinions on various aspects of life. But, alas, Feynman is no more alive today. He died of stomach cancer last year. But it seems before he died he was thinking of writing a sequel to his best-seller which he could not complete. The book under review contains some of his writings to which his letters, lectures and drawings have been added. Obviously, the book, though containing those occasional sparks of insights found in the first one, is not all that entertaining and humorous.

The book is divided into two parts: the first one is a repertoire of interesting incidents from Feynman's own life plus some of his letters drawings and photos; the second one is exclusively devoted to Feynman's role in solving the mystery of the Space Shuttle *Challenger* disaster. In the end a prologue giving Feynman's thoughts on the value of science. It is interesting to note the role Feynman's father, a non-scientist, played in moulding him into a scientist. He

BOOKSHELF

always took young Feynman on long walks and would explain the things that they would encounter on the way. He always emphasised that things, howsoever complicated that they may look, could be explained. In his school and college days, Feynman was therefore always experimenting with things and was as a result considered a crank, and what not. Subsequently, Feynman goes over to his first love, Arlene, whom he met during his college days. The title of the book is after this piece because Feynman married Arlene despite the fact that she was suffering from cancer. His affair ended only with her death. Then the other pieces range from Feynman's encounters with foreigners, hotel-life, female chauvinism, so on, so forth. His detailed personal report on the *Challenger* disaster throws much light on how the American political and scientific machinery works.

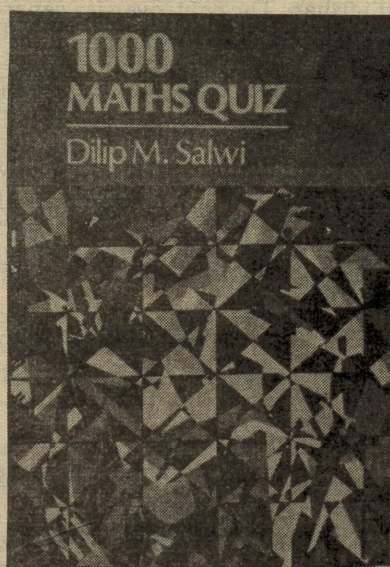
The book would be of interest to any Feynman fan because, apart from his writings, it also contains his line drawings and sketches.

Dilip M. Salwi

1000 MATHS QUIZ by Dilip M. Salwi, *Rupa & Co.*, 3831, Pataudi House Road, Daryaganj, New Delhi-110 002, Pp. 144, Rs. 30.00

MATHEMATICS is regarded as an abstract subject. That is the reason why to many, mathematics is simply boring and meaningless. However, mathematics has great potential and is a powerful tool for solving many practical problems. Therefore, enormous power of mathematics needs to be recognised and appreciated. While it may be true that mathematics divorced from real-life problems can be dull and uninteresting which, for example, is the

case with textbook type mathematics involving abstract formulae, equations, etc. However, there is another side of the matter as well. Apart from dry, technical and uninteresting mathematical jargon there are interesting, exciting and enjoyable facets of mathematics too. Only these aspects need to be explored and brought to the surface. This is pre-



cisely what the puzzle books and books on recreational mathematics serve to do. An attractive, mind-stimulating and ready method for testing knowledge and awareness in a particular area of study can be through quizzes. However, quiz books on mathematics are scarce. The book '1000 Maths Quiz' is, therefore, a welcome gesture from the well-known science populariser, Dilip M. Salwi.

The book is a brilliant collection of 1000 diverse questions on various aspects of mathematics. These include curiosities, humour, paradoxes, mathematical games and puzzles, numbers, computers, instruments, and machines. Mathematics has also affected humanities and culture, even language and religion. All these varied aspects are profusely

dealt with in the various quizzes included in the book. Even such abstract topics as solids, curves, theorems, equations, series, geometrics have not been skipped by the author. The quizzes also recapitulate some of the valuable contributions of Indians to mathematics. Among the internationally renowned personalities in the field of mathematics some had varied interests while others were versatile in diversified spheres. While one of the mathematicians was a long-distance runner, other was a lawyer. Then there was also a mathematician who was the son of a gardener and bricklayer, the other became a successful businessman while there was still another who was called 'Prince of mathematicians'. The readers will have to go through the book to find all these interesting details about mathematicians.

A great deal of effort and insight has gone in preparing the questions and arranging them topicwise. The author must be congratulated for his effort. However, instead of using "palindrome number" it is preferable to use either "palindromic number" or simply the expression "palindrome". Certainly, the book will be hailed by a wide cross-section of students who are inquisitive and crave for more and more knowledge and information. The book will also have appeal for those students who are preparing for various Entrance and Competitive examinations. The book should, however, be read subject to the qualification laid down by the author himself in the preface to the book, that "this is not a mathematics puzzle book but simply a quiz book with its own limitations and fun". With the expected limitations the book has certainly a lot of fun and valuable information to offer.

P.K. Mukherjee

BOOKSHELF

ISOTOPES IN THE ATOMIC AGE by Hari Jeevan Arnikar, *Wiley Eastern Ltd.* 4835/24 Ansari Road, Darya Ganj, New Delhi-110 002 pp 266, Rs. 150/- (Hard cover)

SOME terms like thermonuclear bombs, particle accelerators, atomic energy, radioisotopes, radiation cancer therapy, radiation sterilization of medical and industrial appliances, etc., though familiar to every one, are not necessarily understood correctly. A country like India with a record of major strides in almost every aspect of nuclear technology can hardly afford to be complacent in this regard. The book under review is most welcome because the bulk of the literature on isotopes is either classified or its scarcely available in reasonable details under one cover. The book is all the more welcome when it comes from the pen of a celebrated teacher and scientist like Professor Hari Jeevan Arnikar.

Although the author has not mentioned any particular level of readership for the book, the reviewer feels that familiarity of the reader with basic concepts of atomic physics, chemistry and thermodynamics is expected. In fact, in modern times, every honours and post-graduate student of physics and chemistry using or not using isotopes should at least be familiar with what stable and radio isotopes are, the techniques of their separation, enrichment detection, handling, transportation, safe upkeep and use in laboratories, hospitals and industries. The subject matter under all these headings is very vast and perhaps beyond the scope of a single comprehensive title. And most appropriately the title under review deals mostly with the methods both, classical and recent ones of separation and enrichment of isotopes required on industrial scales.

The subject matter has been covered in twelve chapters. The first chapter on isotope provides a brief historical account of the development of the concepts of isotopes, their chemical identity and isotope effects (both nuclear and chemical), and introduces the reader to some quantum mechanical concepts. The subsequent eleven chapters are devoted to statistical thermodynamical considerations, chemical isotope effects, isotope enrichment, electromagnetic separation, physical methods of isotope separation, equilibrium exchange processes, irreversible methods, large-scale separation of stable isotopes, reactor-fuel isotopes, radio isotopes and the multifarious uses of radio isotopes. An appendix at the end provides a tabulated information on the important characteristics of some of the more commonly used radio isotopes. Specific sources of information pertaining to individual chapter have been given at the end of every chapter in addition to a general bibliography.

The treatment of the subject matter of individual chapters, though brief and to the point and yet without rigorous mathematics, is comprehensive and thorough. Starting with the basic principles of each and every method of isotope separation, the author has provided insights into their relative efficiencies, advantages and limitations as well. In this respect, tabulated information giving the highest separation factors achievable or at least known for every method of isotope separation would have been desired, although compilation of this kind of information may not be easy for various reasons. The author should have also included some unclassified photographs of some of the practical industrial establishments for separation of isotopes, e.g., cascade method by gaseous diffusion, to give the reader an idea of the

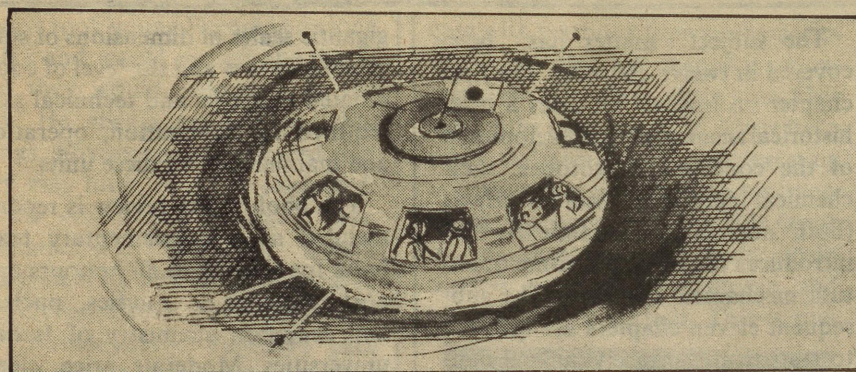
gigantic scales of dimensions of such establishments and the level of coordinated scientific and technical skill required for fabrication, operation and maintenance of these units.

The book under review is recommended as a supplementary textbook for reading to all honours and post-graduates in physics, nuclear and radiation chemistry of Indian universities. Moderate price, clear, well drawn illustrations and almost mistake-free printing are its plus points.

A.V. Moharir

Books Received

1. **BRAHMA'S HAIR—THE MYTHOLOGY OF INDIAN PLANTS** by Maneka Gandhi, *Rupa & Co.*, 3831, Pataudi House Road, Daryaganj, New Delhi-110002, Pp 176, Rs. 30.00 (ISBN 81 7167 005 9)
2. **THE ROBOTS ARE COMING—Stories of Robots** by Dilip M. Salwi, *Ratna Sagar Pvt Ltd*, Virat Bhawan, Mukherjee Nagar Commercial Complex, Delhi-110009 Pp. 93, Rs. 18.90 (ISBN 81-7070-081-7)
3. **INTRODUCTION TO MODERN PHYSICS** by H.S. Mani and G.K. Mehta, *Affiliated East-West Press Pvt. Ltd.*, G-1 16, Ansari Road, New Delhi-110 002, Pp. 443, Rs. 51.50.
4. **FASCINATING WORLD OF MATHEMATICAL SCIENCES:** Vol I **Nature of Mathematics**, Vol-II **Applications of Mathematics**; Vol. III **Applications of Mathematics**; and Vol. IV **Mathematics Education**; all by J.N. Kapur, *Mathematical Sciences Trust Society*, C-766, New Friends Colony, New Delhi-110 065, Pp. 264, Pp. 272, Pp. 256, and Pp. 256, Rs. 95.00 each.



A Hotel Up Above The Sky So High

JAPAN has entered the space age and is only the third nation in the world, after the Soviet Union and the United States, to reach for the moon. The Japanese space plans are predictably different from those of the two superpowers, though.

Japanese have a style built around an uncanny sense of business. While the Soviets and the Americans invested heavily over the past four decades in what turned out to be a vigorous race for supremacy in space, the Japanese bade their time. And when they launched their first moon-bound rocket Muses-A from its pad in Uchinoura near Kagoshima on the western main island of Kyushu on 23 January 1990, they also let the world know that they have many esoteric programmes, some of them straight out of science fiction. For example, they expect to build the first hotel in space before 2020. The 64-room doughnut-shaped hotel will be stationed about 450 km above the earth, and it would cost, according to current estimates, about \$165,000 per person per weekend.

Other programmes of the ambitious Japanese space plan include:

1. Landing three people on the moon around the year 2010 to build a temporary moon base, for which Japanese scientists already have the necessary technological capabilities;

2. Making further forays into space from the manned moon base;

3. Building a whole city on the moon, complete with hotels, farms, offices, research stations and a sports and recreations centre; and

4. Developing a new kind of space vehicle to shuttle people and material back and forth between earth and orbiting space stations.

Reverting back to the present, Muses-A, carrying two satellites, is

expected to intercept the moon's orbit on 21 March 1990, when one of the satellites will begin to orbit the moon and the other will return to orbit the earth. According to Yasunori Matogawa of Japan's Institute of Space and Astronautical Sciences, the purpose of the Muses-A mission, the first lunar mission in 24 years since the unmanned Soviet Luna 24 landed on the moon in August 1976, is "to swing by the moon and learn to use lunar gravity to control satellite orbits."

The next major project is the development of a powerful rocket, the H-2, capable of carrying huge payloads into space. The H-2 is scheduled to be launched in 1993.

At least nine government agencies are involved in the Japanese space programme, but all their plans and targets will go awry if the Ministry of Finance finds it difficult to provide the huge funds needed.

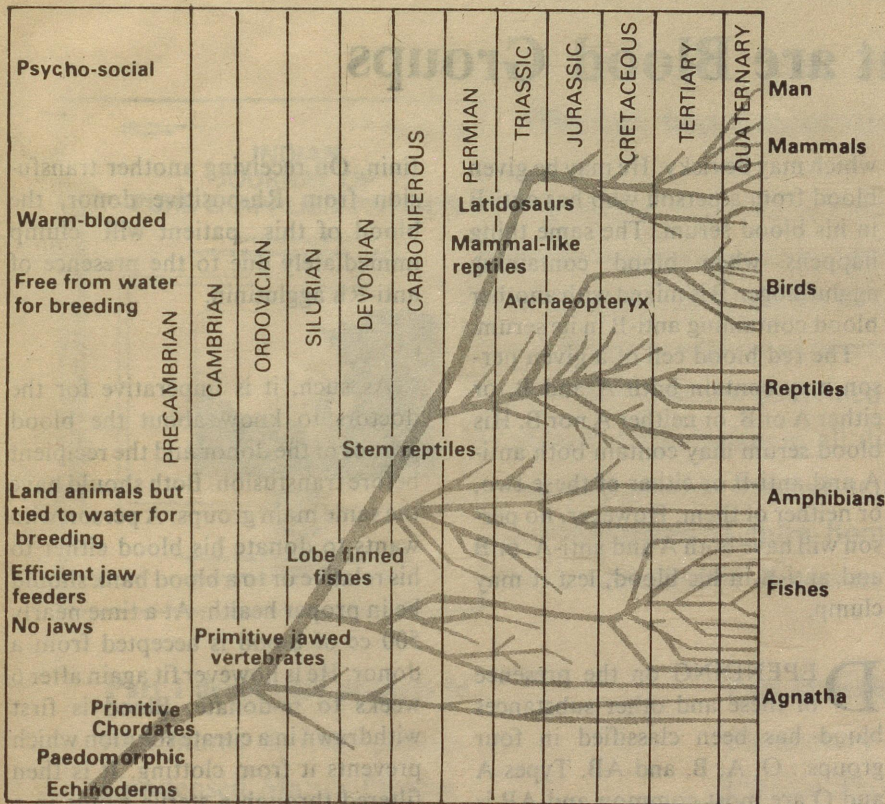
S.A.

Burgess Shale: A New Look at Evolution

HOW did life on earth begin? When did the first man appear on the scene? For centuries answers to these questions came from religious scriptures. But then came Charles Darwin and about 130 years ago he quietly sent Adam and Eve packing from the Garden of Eden when he published his classic *The Origin of Species*. Along with the virtual demise of creationism—yes, the demise was not total, for even today there are a number of people and organisations demanding equal time for creationism in the classroom if not for the total abolition of the teaching of the theory of evolution, even in scientifically advanced countries like the USA—Darwin's work

led to the emergence of a comforting consensus that man is the fulfilment of the evolutionary process. If natural selection is about the survival of the fittest, is it not reassuring then to know that humanity is at the pinnacle of the living world? Not only have we escaped extinction and survived the elements for millennia, but have also tamed other creatures of much higher physical strength. Like Muhammad Ali, we tend to feel we are the greatest, or at least the fittest. In its own way, Darwin's theory of evolution—like most theological works before and after his time—led us to believe in the uniquely favoured position of man in the scheme of things. We turned Darwin's theory to suit our predilection for anthropo-

HORIZON



"There was no inevitable development of ever-increasing diversity, no inexorable ascent from primitive ancestors to today's sophisticated mammals. The path does not stretch from insensate single-celled creatures to the development of intelligence and consciousness." On the contrary, about 570 million years ago, in what is now known as the Cambrian explosion, there appeared all of a sudden—in evolutionary time scale—an outburst of biological creatures of such diversity that the variety of forms living then far surpassed the entire animal kingdom of today. And the Burgess Shale has recorded this great outburst and preserved the fossils of many of these creatures.

Creatures representing 25 different body plans or biological designs are found in the Burgess Shale, but only four of them survived to spawn all the immense variety of life forms that we see today—including man. What made these four designs survive and the rest extinct? Were these four in some way marked for success, more abundant, more flexible, more efficient than the others? No, says Gould. They survived, period. There was no inevitability to the development of life on earth.

A little over five hundred years ago, Copernicus threw a spanner in the works of the established order of things when he told that after all the earth was not the centre of the universe, and was condemned for blasphemy. In a way Gould is disturbing the established order of the day too. And his seminal book will, no doubt, be discussed and debated for a long time to come not only by biologists and other men of science but by scholars and philosophers as well.

Subbiah Arunachalam

[Based on a report by Tom Wilkie, the science correspondent of the *The Independent*, London]

centrism.

But what has been found in the Burgess Shale, a 70-foot long outcrop of shale in the mountainous region of the eastern border of British Columbia in Canada, can snatch away all that smug comfort. And the man who brought this discomforting message is none other than Professor Stephen Jay Gould, the Harvard University biologist who over the past fifteen years has emerged as one of the finest interpreters of science to the lay public.

In his latest book, *Wonderful Life*, Gould looks at the Burgess Shale, formed from mud laid down several million years ago. The shale contains fossils of soft-bodied creatures resembling worms and insects which lived on the floor of the primeval ocean about 530 million years ago. These were discovered and classified first about 80 years ago. And a team

of paleontologists from Cambridge led by Harry Whittington revised the classification of the Burgess Shale fossils recently and Gould has interpreted their record of the rocks in his book.

GOULD'S interpretation is bordering on the revolutionary: The evolution of life on earth is contingent and unpredictable. If analogy is permitted, the history of life on earth can be considered as a cassette tape, and Gould says that if we rewind the tape and play it again nothing will be the same. Evolution, says Gould, "was a grand lottery, or at least had very strong elements of a lottery". Which means there was no unique, preordained and inevitable direction in the unfolding history of the evolution of life which ought to have led to a culmination in man!

PLEASE EXPLAIN

What are Blood Groups

BLOOD is thicker than water, but then it may differ from person to person because of certain characteristics it possesses. On this basis human beings have been classified under different groups. This knowledge about different blood groups is very essential when blood of a donor is transfused in a patient who has lost it either due to haemorrhage or accident, or to make up its deficiency in case of anaemia.

In earlier days, blood transfusion was a "hit-or-miss" procedure and costed a large number of lives because in most cases the blood of a donor clumped on reaching the veins of the recipient. Scientists soon found the reason for clump formation. This occurs due to the presence of substances called agglutinogens or antigens in the red blood cells, and agglutinins, the antibodies that originate in the serum of the blood. Serum is the watery fluid which separates when blood coagulates. If red blood cells contain a certain variety of agglutinogen, then these will clump on mixing with another blood whose serum contains a certain variety of agglutinin.

NOW let us see it more clearly. There are two important agglutinogens called A and B. Similarly there are two corresponding agglutinins called anti-A and anti-B. Now suppose, one Mr. X has agglutinogen A in his blood in that case he will not have anti-A agglutinin in his blood serum, though anti-B may be present. If in case of emergency he needs blood and is given by Mr. Y, who has anti-A in his blood serum, then the blood of Mr. X will be clumped immediately on getting transfusion

which may be risky. He may be given blood from a person who has anti-B in his blood serum. The same thing happens when blood containing agglutinogen B is mixed with another blood containing anti-B in its serum.

The red blood cell of a given person may contain both A and B, or either A or B, or neither A nor B. His blood serum may contain both anti-A and anti-B or either of these two, or neither of them. However, no person will have both A and anti-A, or B and anti-B in his blood, lest it may clump.

DEPENDING on the presence of these and other substances blood has been classified in four groups : O, A, B, and AB. Types A and O are most common and AB is the rarest. In addition to these there are other groups as well. One such

group is based on the so-called Rh factor, and agglutinogen found in the red cells of most people and rhesus monkey (we will take up Rh factor next time). The blood containing Rh factor is called Rh-positive and without it, Rh-negative.

tinin. On receiving another transfusion from Rh-positive donor, the blood of this patient will clump immediately due to the presence of anti-Rh agglutinin.

As such, it is imperative for the doctors to know about the blood groups of the donor and the recipient before transfusion. Both should have the same main groups. A person who wants to donate his blood either to his relative or to a blood bank should be in proper health. At a time nearly 500 cc of blood is accepted from a donor. He is however fit again after 6 weeks to re-donate. Blood is first withdrawn in a citrate solution which prevents it from clotting. It is then filtered through a sterile gauge in a bottle which is kept at a height on a stand during transfusion.

Group	Agglutinogens in RBCs		Agglutinins in serum	
	A	B	Anti A	Anti B
O	None	None	Present	Present
A	Present	None	None	Present
B	None	Present	Present	None
AB	Present	Present	None	None

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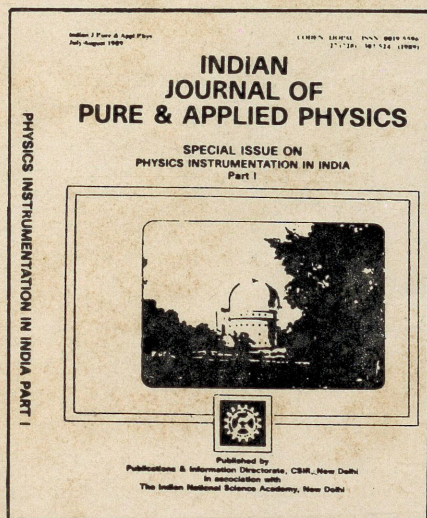
If the blood from a n Rh-positive person is transfused in the body of a n Rh-negative person, the serum of the latter will produce an anti-Rh agglu-

In case of extreme emergency however blood of group O can be given to patient of any group. Similarly, patients of group AB may be given blood from donors belonging to any of the three other groups.

It is always necessary to find that the donor's blood does not contain agents of transmitting diseases such as hepatitis and AIDS

C.B. Sharma

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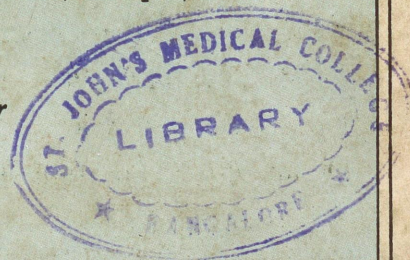
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