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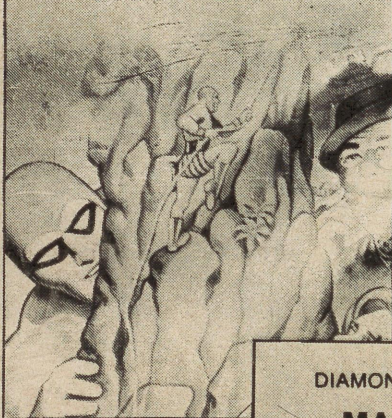
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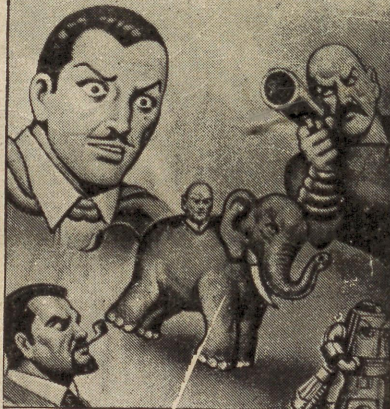
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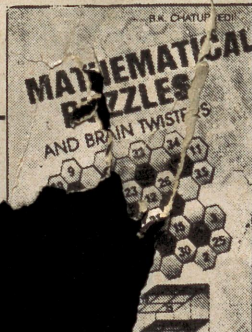


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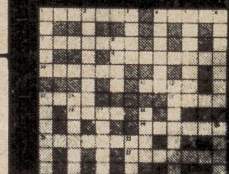


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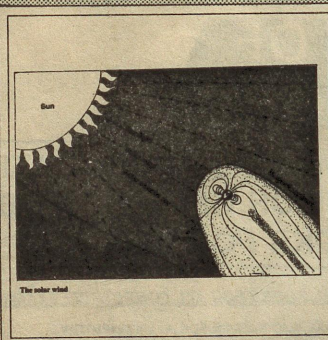


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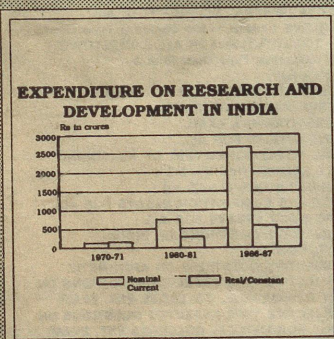
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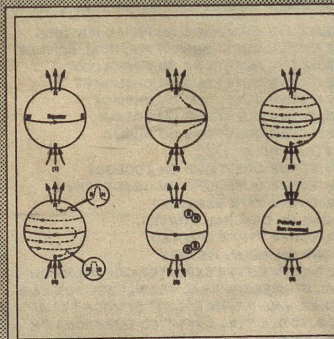
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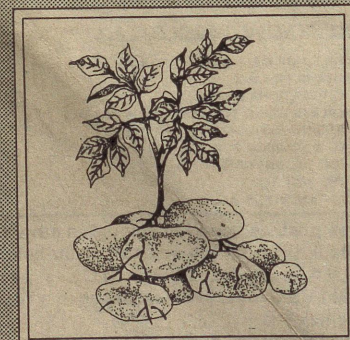
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COVER STORY

9 AURORAS : THE MOVING LIGHTS IN THE SKY CHANCHAL UBEROI

Spectacular lights dancing in the night skies of the polar region are caused by disturbances in the earth's magnetic field

ARTICLE

17 SELLING RESEARCH G. VENKATARAMAN

A different approach and strategy is necessary to make Indian research efforts industrially viable

28 SUNSPOTS : IS THE SUN'S CLOCK A PENDULUM? PHILIP R. GOODE

The reasons for the occurrence of sunspots at regular intervals disturbing the earth's magnetic field still remain a mystery

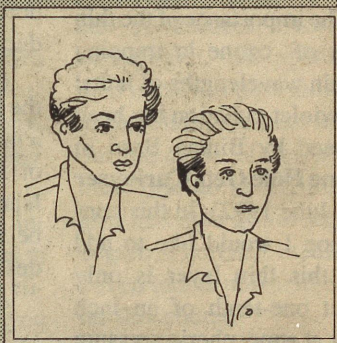
37 POTATOES VIRENDER SARDANA

This popular tuber is not only a good source of nutrition but also of industrially important raw materials

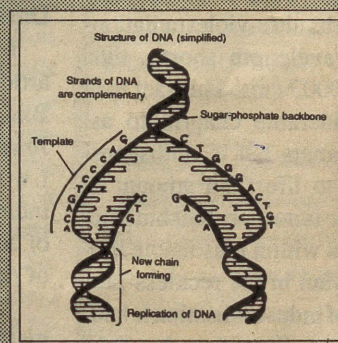
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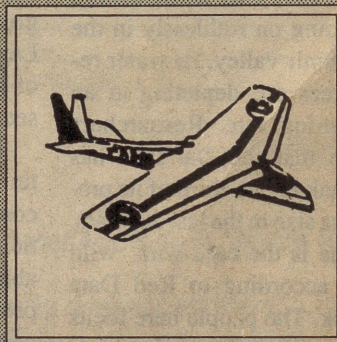
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Ozone Depletion

The importance of the thin layer of ozone in trapping certain wavelengths of lethal ultraviolet radiation has been stressed by Biman Basu in **Ozone Hole Gets Curiouser** (*SR*, June 1992). In this connection I would like to add that this thin layer is only about one-tenth of an inch thick at atmospheric pressure and room temperature. Although thin, it completely absorbs ultra-violet radiations of wavelength shorter than 0.000003 cms. This fact is of considerable chagrin to astronomers but is indispensable to life. The amount of ozone is not constant but fluctuates within reasonable limits. Man in his reckless pursuit of industrialisation is hell-bent on disturbing this delicate balance as is apparent from the phenomenon of ozone hole. We should do well to remember that we have not inherited the earth from our parents, we have borrowed it from our children.

S. K. Gurtu
Delhi

Vanishing Valley

I was deeply impressed by the cover story **Restoring India's Forest Wealth** (*SR*, June 1992). As deforestation is going on ruthlessly in the Kashmir valley, its water resources are depleting at an alarming rate. Researchers state that the Dal lake has shrunk to one-third of its previous size in the last 30 years. Same is the case with wild life according to Red Data Book. The people here focus on maximizing their short-

term profits and forget to stop deforestation. This has reduced our forests to only 9%.

All this adversely affects the tourism industry which is a major commercial industry of Kashmir and one day I fear, this beautiful valley will be another man made Thar desert.

Amjad Masood Husaini
Srinagar (J&K)

Dark Matter

I read with interest the article **Relics Of The Big Bang** by Biman Basu (*SR*, June 1992). In this connection, I would like to share a few interesting facts with readers of *SR* regarding the enigma of dark matter.

The existence of dark matter first came into light in the 1930s when some distant galaxy clusters and certain galaxies including the one named NCG-3184 were found behaving oddly. The galaxies in the clusters, instead of moving away from each other as the Big Bang theory suggests were, in fact, closely held together as if bound by a tremendous force of gravity. Also, the outer most parts of the individual galaxies were not slowing down as one would expect going by the Newtonian Laws. Strangely, the source of the gravity remained unseen.

The so-called 'dark matter' is now believed to be composed of neutrino particles instead of the detectable particles like neutrons, protons and electrons. The neutrino particles, it is said,

came into being just after the Big Bang when the four forces—electromagnetic force, gravitational force, strong nuclear force and weak nuclear force—were partly converted into matter. What makes the dark matter 'invisible' is the fact that neutrino particles normally don't react with ordinary substances under ordinary conditions and there are no suitable techniques and instruments which can detect neutrinos in the outer space.

The enigma of dark matter is likely to remain until more advanced and ingenious methods are employed.

Sudipto Chakravarty
Udaipur (Rajasthan)

More Insight

Congratulations to both Ghosh and Dey for presenting the "Vision-Story" so interestingly in the article **Visual Sensors** (*SR*, May 1992). But science still cannot explain how our eyes make the world around us look so colourful. Science has only a hazy picture about colour-visualisation. At present, what we know with certainty is that the light converts rhodopsin of rod-cells to a metastable form—metarhodopsin-II (M. II). M. II in turn, activates G-protein (transducin) whose active part (GX-GTP) then activates an enzyme—"phosphodiesterase". The latter hydrolyses another chemical *CGMP* (3'-5' cycle GMP) and thus causes a decrease in the sodium ion passage across the rod-cell membrane. *CGMP*

stimulates sodium ion passage. This leads to hyperpolarisation of the cell-membrane which signals the movement of an as yet unidentified chemical transmitter to the bipolar cell that is in contact with the rod. The bipolar cell then sends the signals to brain through retinal neurons.

Lal Babu Prasad
Varanasi (U.P.)

Cadmium

A.K. De's interesting article **Cadmium—The Polluter Around Us** (*SR*, May 1992) was brief but very informative. The readers would like to have more detailed information on topics related to health and well-being. As far as cadmium being the cause of the disease *itai-itai*, Roy M. Harrison writes : "There are some dissenting voices raised against this proposition, however. The disease has been found in women who, for religious reasons, covered themselves and kept themselves indoors and out of sun. It seems likely that deficiencies of calcium and vitamin D were at least partially to blame and that cadmium may have been acting only as one factor in what was a multifactorial aetiology for this disease (*Fed. Proce.*, 1976, 35, 2412)".

B. K. Kapadia
Bombay

Food For Thought

The write-up on **Nutrition Disc** (*SR*, April 1992) was very interesting and infor-

REACTIONS

native. It is needed not only "For Her", but also for him and for all. Proper diet and nutrition is not only good for health but also helps build immunity against various diseases. For a balanced diet we need the sense of choosing the right food-stuffs according to their nutritive value. The nutrition disc presented by Dr Kapil is most welcome in this respect. It gives all the information to a layman about the nutritive value of different food-stuffs and helps in preparing a balanced diet.

Biswajit Roy
Chinsura (W.B.)

Human Genome

Kudos for transforming *SR* into a magazine helpful to students. With regard to the interview with Severo Ochoa

(*SR*, April 1992) I would like to inform readers that I had a talk with Prof. Charles, R. Cantor, Chairman, Human Genome Organisation. He said that "it is not desirable and neither useful to decode the gene sequence of a single individual because the individual may not be carrying all the genes of the several thousand diseases known to mankind. Hence, this project is studying hundreds of people on the basis of pattern of disease inheritance in their families."

Anshul Dikshit
Varanasi (U.P.)

Forensic Career

I am a regular reader of your column **Crime Busters**. I have made up my mind to become a crime scientist

myself. Please tell me how I can choose this career.

Jagannath Mishra
Bhubaneswar
Umesh N. Jhavar,
Ghatkopar

Many universities in India offer M. Sc. courses in Forensic Sciences. To be eligible for these courses you should have a bachelor's degree, preferably with a first division in physics, chemistry, zoology or botany. You can find out about the details of admission to this course from your local state university. Once you have done the M. Sc. successfully you can even go for a Ph. D in Forensic Sciences. In your M. Sc. course you can choose a field of specialization such as forensic ballistics, forensic en-

tomology, forensic botany etc. To become a forensic pathologist, the specialist who conducts post-mortems on dead human bodies to find out the cause of death, you must first do an MBBS degree and then go for an MD degree in Forensic medicine. Seven Indian universities offer this course.

Anil Aggrawal

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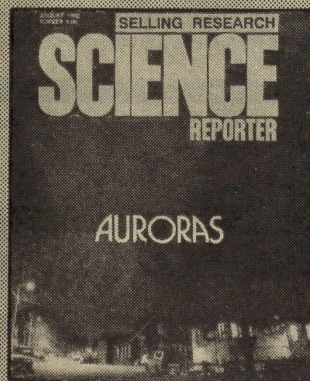
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Should Dams Be Damned?

ONE of the mainstays of India's post-independence development have been the major multipurpose river valley projects. They have not only helped the country in raising its power generation substantially but have also been instrumental in ushering in the Green Revolution. But have they done all good? Perhaps not. Salinization of fertile agricultural land, displacement of people from areas submerged by impounded water are frequently cited as arguments against large dams. But these are not unsurmountable problems. Environmental degradation and human suffering can both be avoided or at least reduced to a large extent by proper advanced planning.

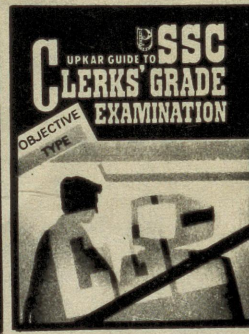
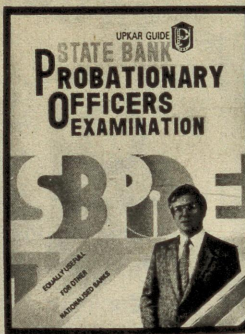
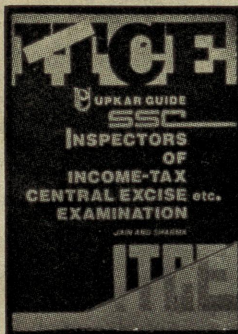
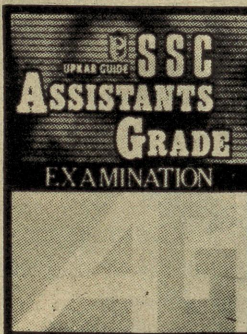
As Mostafa Kamal Tolba, Executive Director of the United Nations Environment Programme once commented, water development projects have both positive and negative impacts. Unfortunately, recent debates in the country such as those on the Tehri and Narmada projects have concentrated primarily on the negative impacts. What perhaps is being lost sight of are the positive impacts of sustainable water management that large dams can provide.

A classic case of a much maligned dam is the Aswan High Dam across the Nile in Egypt. Soon after it was completed in 1970 environmentalists castigated it as an ecological disaster. Apprehensions were expressed about loss of soil fertility down-stream which regularly experienced annual flooding before the dam came up. Fears were also expressed about a rise in cases of the snail-borne disease schistosomiasis. True, some of these fears have turned out to be real, but, looking back, they appear to have been much exaggerated or capable of being tackled or subject to amelioration. On the contrary, the benefits from the dam now appear to far outweigh its negative impacts. The Aswan High Dam is today a boon to the Egyptian economy.

The same would perhaps hold true for our own dams, Narmada and Tehri included. There will no doubt be some negative environmental or social impacts, but they cannot all be termed as unsurmountable. Many of them can be taken care of by nothing more than an open exchange of views between all concerned sections. But rhetorics and antics to stall the projects will benefit none, not even those who are crying hoarse to stop them. Nor would going ahead with the construction in total disregard of constructive criticism would help. It is time to act sensibly, keeping in view the enormous benefits these projects can provide to the common man, rather than merely damning the dams.

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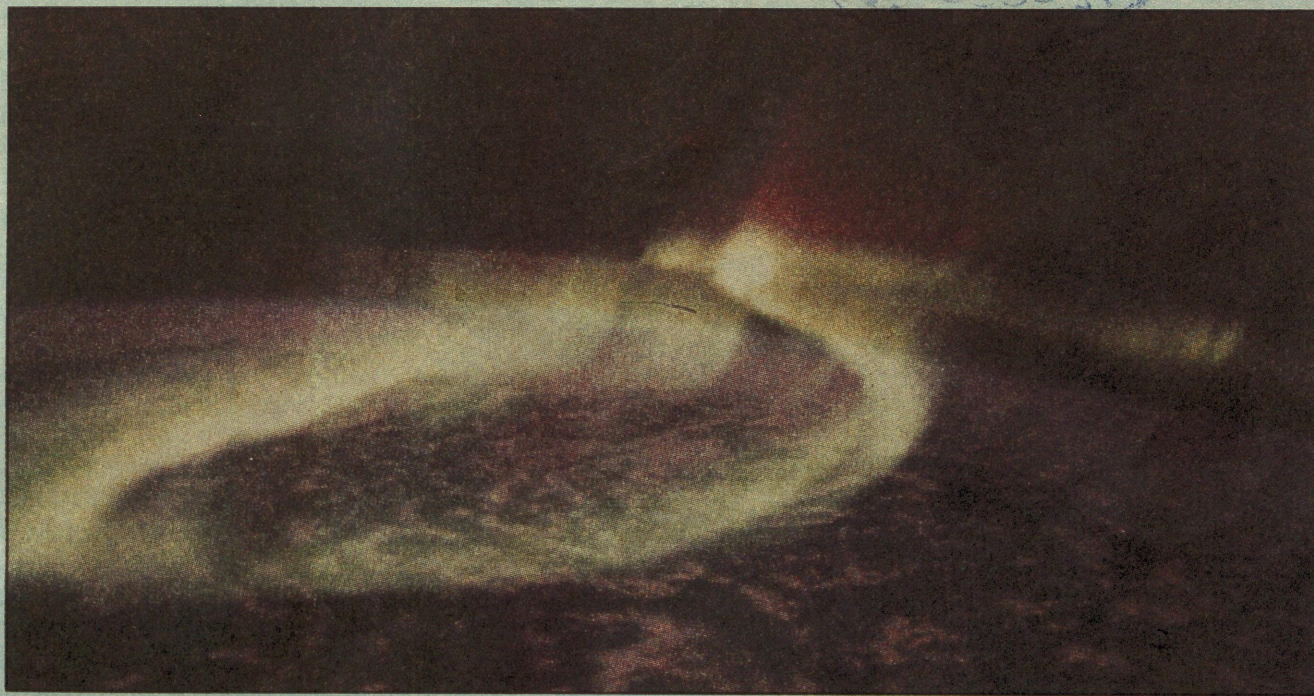


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Aurora australis over the Antarctica taken by astronauts aboard the space shuttle 'Discovery'

AURORAS

The Moving Lights in the Sky

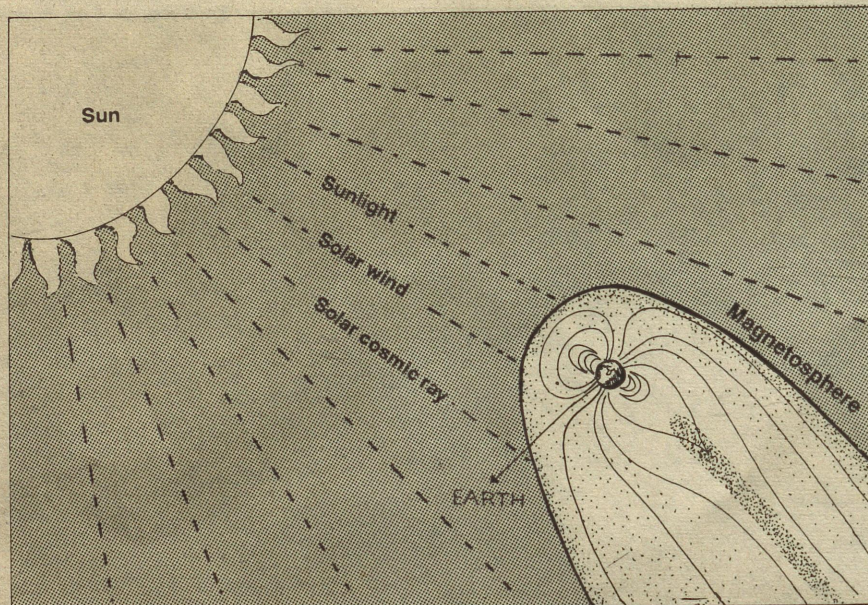
THE word "Aurora" means Goddess of Dawn. In Sanskrit also therefore aurora is appropriately known as *Ushas*, the bright morning. As the name suggests, auroras are spectacular displays of luminous radiation in the sky near polar regions. The light is so bright that it appears as if the morning has arrived. The auroras occur simultaneously in both the polar regions, with their symmetry defined by the earth's magnetic field. The northern aurora is known as aurora borealis (Northern Dawn). This name was given by Gassendi (1592-1655), a French astronomer

**Auroras are
spectacular displays
of light in the sky.
CHANCHAL UBEROI
throws light on
how they occur.**

and mathematician, after seeing an outstanding display of aurora in southern France on 12 September, 1621. The

southern aurora is called aurora australis (Southern Dawn). The first record of aurora australis is by Captain Cook (1728-1779) who saw it on 19 February, 1773 when in latitude 57° 6' S in the Indian Ocean and gave it this name.

From the ground, aurora appears to be a curtain of light, streaked with rays. The curtain begins at an altitude of several hundred kilometers above the ground, almost ten times the height at which airliners fly. The sheet is less than a kilometer thick, but it extends laterally for thousands of kilometers. The streaks of ray always show shimmering waves. It is always seen to ebb



The solar wind

across the polar sky. This movement made the ancient observers give it the name "moving light in the sky". Perhaps for an Indian reader the best title will be "flying sarees in the sky"!

Why do we not see the aurora in India? It is because the aurora usually occurs over high latitudes, mainly between 65 to 80 degrees north or south geographic latitudes. The sighting of auroral light at low latitudes as in India is a rare phenomenon. There is however, an interesting historical record that an unusual aurora was observed from Bombay, as well as in many other parts of India on 4 February, 1872.

AURORAS have been recorded at least since the time of Aristotle. There are interesting accounts by medieval and ancient writers which describe auroras in fanciful or superstitious ways. In one account it is mentioned as a "blood-colored" and then as a "terrible portent", "a conflagration falling earthward". Aristotle himself referred to them as chasms (*chasmata*). This may imply that he thought them to be cracks in the dark sky, through which flames beyond could be seen.

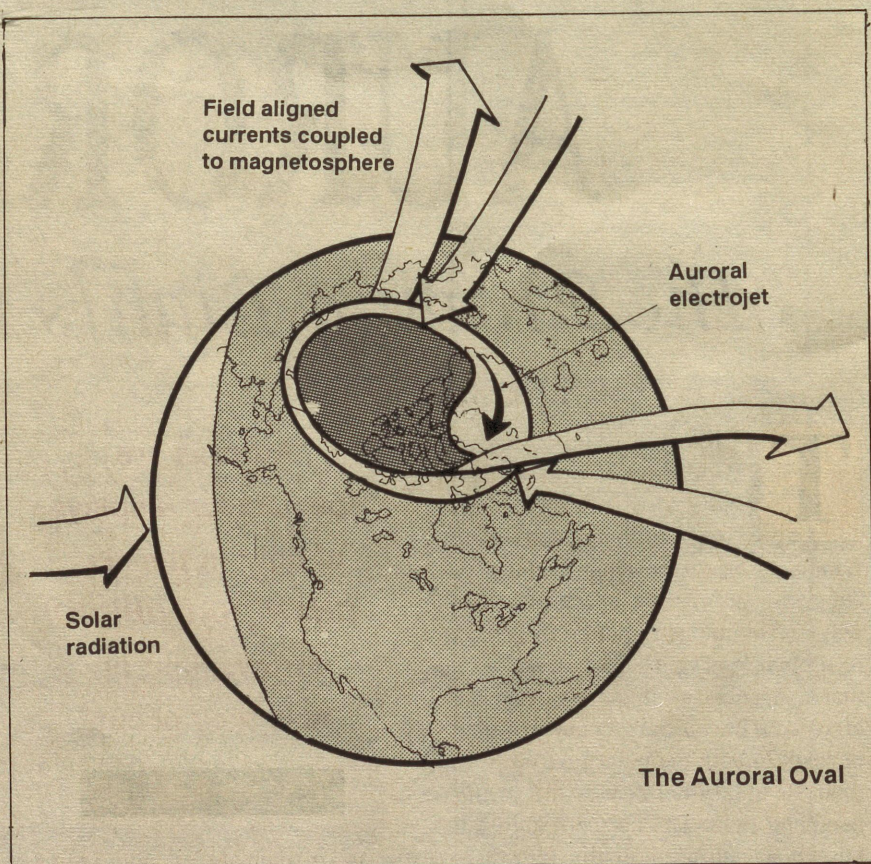
The glorious sight of an aurora inspired many to come out with vivid poetic accounts of the phenomenon. The Russian scientist Lomonosov in 1743 wrote the following verse:

*"But, where O Nature, is thy law?
From the midnight lands comes up
the dawn!"*

*Is it not the sun setting his throne?
Is it not the icy seas that are flashing
fire?"*

*Lo, a cold flame has covered us!
Lo, in the night-time day has come
upon the earth."*

What causes an aurora? From the Greek times, almost to the very early part of this century, a great variety of causes and associations have been proposed. In early times associations with shooting stars, earthquakes and the weather were suggested and the phenomenon was supposed to be caused by



Auroral oval. Auroral light is primarily emissions from oxygen atoms and molecular nitrogen. The picture shows the connections between the electric currents in the aurora and those in the magnetosphere

vapours, ether, exhalations, or electric discharges. It was later thought that these spectacular colourful displays in the arctic sky resulted from the refraction of sunlight in the atmosphere much like the formation of a rainbow. The shimmering undulations, it was speculated, were caused by the movement of air. Physicists today know that the auroras are lights emitted when atoms and molecules in the ionosphere are struck by high-energy electrons coming from the sun. The apparent motion of the auroral curtain is caused not by atmospheric turbulence but by changes in the electromagnetic conditions that propel the electrons, just as a moving picture on a television screen is an illusion created by changes in magnetic field that directs electrons from an electron gun onto the screen.

But what, in the case of aurora, serves as the electron gun? Where does it get its power supply? Why does the power fluctuate from time to time causing the aurora to ebb and flow across the polar sky like colourful flying sarees spread out by a dyer? It is now known, though not fully understood, that auroras occur due to some complex interaction between the solar wind (a thin plasma of hydrogen ions and electrons constantly streaming away from the sun) and the earth's magnetosphere.

The matter in the earth's magnetosphere is in the form of plasma consisting of charged particles. Some of the solar wind particles interact with these particles in the magnetosphere to cause the electrical discharges that produce auroral displays. Thus, the magneto-

sphere behaves as a gigantic generator that produces upto ten million megawatts of electrical power. The electric currents generated in magnetosphere are guided along the lines of Earth's magnetic field. These field-aligned currents are responsible for the curtain-shape of the aurora. They also control the location of the aurora as well. The field-aligned currents, by complicated

processes, reach the lower ionosphere forming the lower edge of the aurora at a height of about 100 km. The top of the auroral curtain may extend upto a height of 500 km. The electric currents flow to and from the northern and southern polar regions, producing basically identical auroral forms.

The geomagnetic nature of the aurora is now well verified by observations from outer space.

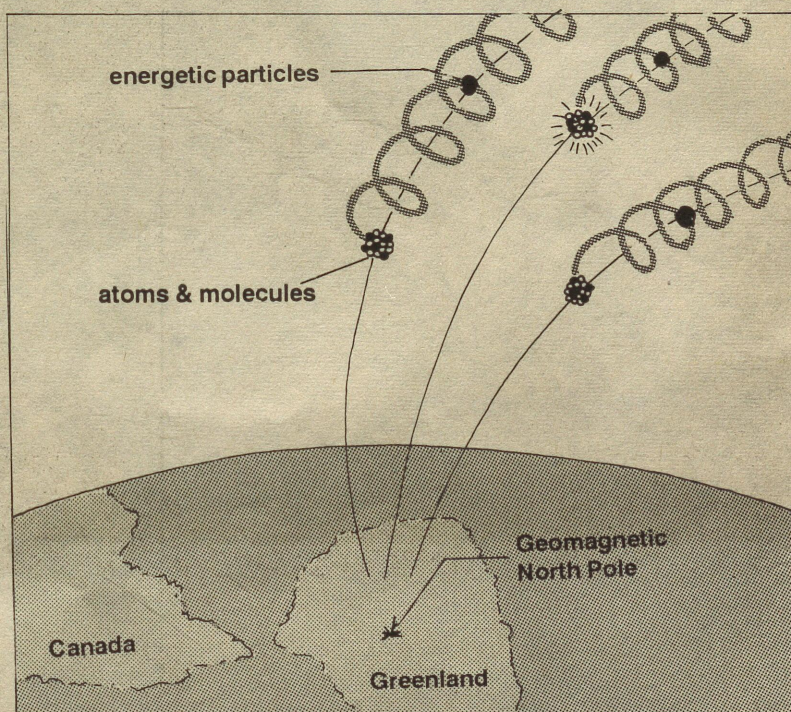
Centered on each of the geomagnetic poles is a large luminous oval which is a permanent feature of the planet. Auroras occur virtually every night about auroral ovals over both magnetic poles. The northern auroral oval is roughly centered at the north geomagnetic pole — not the geographic north pole — and it stretches across Alaska and northern Canada, the southern tip of Greenland and Iceland, the northern coast of Norway, and a little off the Siberian coast.

The southern auroral oval is centered on the geomagnetic

pole in the Antarctic. Aurora australis is seen rarely, however, because this auroral oval passes mostly over uninhabited areas like parts of Antarctica and the southern Indian Ocean.

Africa, South America and Australia are too far from the southern magnetic pole to have frequent auroral displays. Possibly, that is why aurora australis was not discovered until 1773.

Most of the time northern and southern auroras are exactly alike and move around in the same way at the same time. This was verified in 1967 when scientists discovered that electrons causing both auroras come from the same



Energetic particles, particularly electrons rain down along earth's magnetic field lines and produce the auroras on interacting with the molecules of atmospheric gases

Auroras are lights emitted when atoms in the ionosphere are struck by high-energy electrons coming from the sun.



Auroral bands (Courtesy : Lee Snyder)

source, creating simultaneous and often mirror-image auroras in the north and south polar regions. This was shown by using two specially equipped aircrafts to fly co-ordinated round trips across the northern and southern auroral ovals. The aircrafts reached conjugate points simultaneously to record the state of both the northern and southern auroras.

NEXT question is, what causes the spectacular colours of aurora? The potential difference across the aurora and the field-aligned currents accelerate the electrons coming from the sun along the magnetic field lines. When this 'rain' of electrons reaches the ionosphere, and impinges on atoms and molecules in the lower ionosphere, radiation is emitted. Different types of collisions with different

types of molecules or atoms give rise to different coloured emissions. The atoms and molecules which are important are oxygen and nitrogen. When oxygen and nitrogen atoms are hit by energetic particles they are excited or ionized and give off light at characteristic wavelengths as they return to their normal states. The green-white emission is produced by oxygen atoms between 110 and 250 km up. A rather steady red glow is produced when oxygen atoms are hit by less energetic particles at heights of some 300 to 400 km. Nitrogen atoms also produce green-coloured emission but with a much wider distribution. Ionized nitrogen molecules produce blue light; neutral nitrogen molecules create the purplish-red colours of the lower borders and ripple edges of auroras.

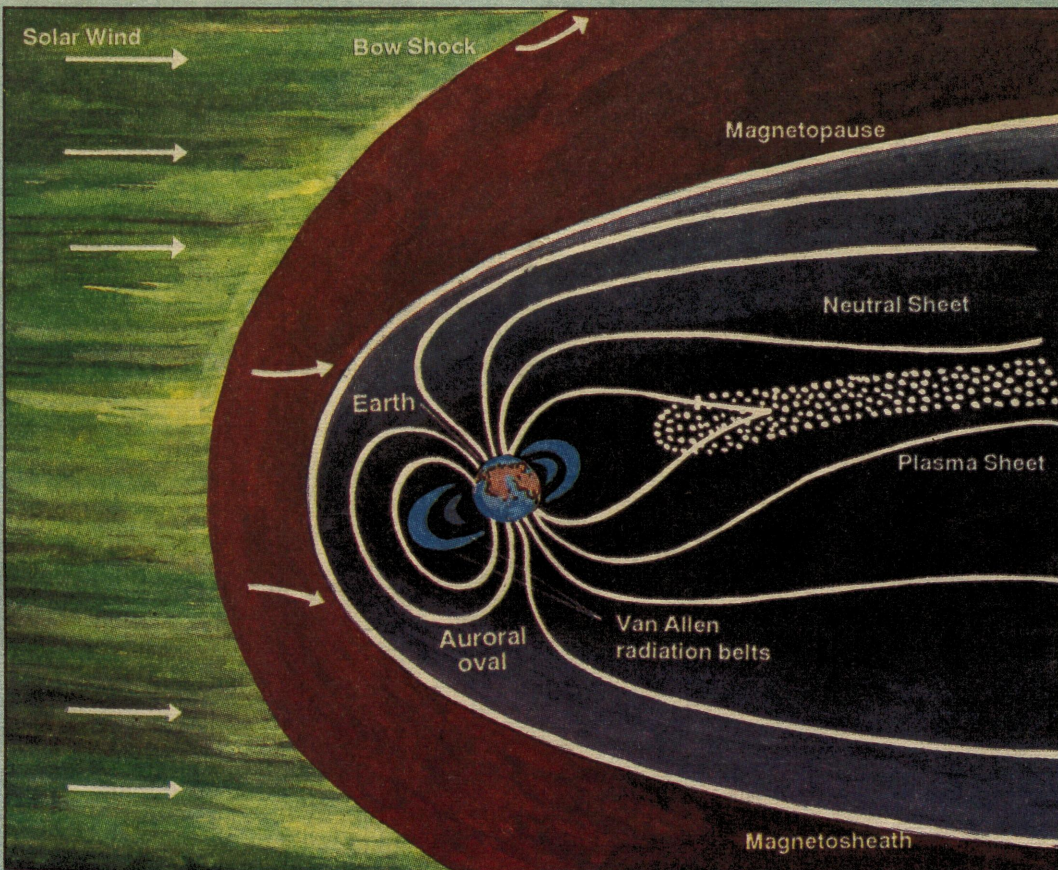
The auroral substorm is an intermit-

tent surge of auroral activity arising due to electromagnetic disturbances in the magnetosphere. The first sign of a typical auroral substorm is the sudden brightening of the auroral curtain in the midnight sector. The brightening rapidly spreads westward and eastward until, after about ten minutes, an auroral curtain in the entire dark hemisphere brightens. A westward travelling surge then propagates along the auroral curtain and it develops a largescale fold, making it the most spectacular display that can be observed from the ground. Auroral activity is closely related to the sunspot activity of the sun.

From late evening to early morning hours an aurora watcher will see successive auroral substorms. Between seven and ten in the evening the aurora appears as an "arc" — a uniform strip of



▲ Aurora over the University of Alaska (Courtesy: Al McNeil)



▲ The details of the magnetosphere surrounding the earth

COVER STORY

light stretching from one horizon to another. Later in the evening, if a substorm happens, the auroral form becomes more active and it develops line folds and is called a "rayed arc". With more intense activation, larger scale folds are superposed on the rayed arc form; such a fold of scale of the order of a few hundred kilometres develops.

After midnight the aurora often becomes quite different. From being active and filling the entire sky, it seems almost disappearing, except for a white or pale green color throughout the sky. Then, patches of light slowly start to appear. They often look like a puff of smoke or fluffy clouds. Patches usually blink on and off in a regular pattern ranging from one or two seconds up to half a minute. They are called pulsating auroras.

Sometimes toward the morning, the patches disappear and long auroral rays appear again. Later, as the sun rises, the

aurora can no longer be seen because it is dimmer than the daylight. During the day the aurora also moves far to the north, so even if it were visible, it would only occur over uninhabited areas.

It is very interesting to note that for thousands of years there have been, and even today there are reports from people about 'hearing' the aurora. Several different sounds have been reported, but most are described as a very quiet swish or a faint crackling. The sounds have usually been heard during the time rayed bands move rapidly overhead.

Scientists are puzzled by these reports, because the air ninety kilometers above the earth is too thin to carry sound. Yet reports describing these sounds continue to come. But all attempts to make recordings of them have failed till now.

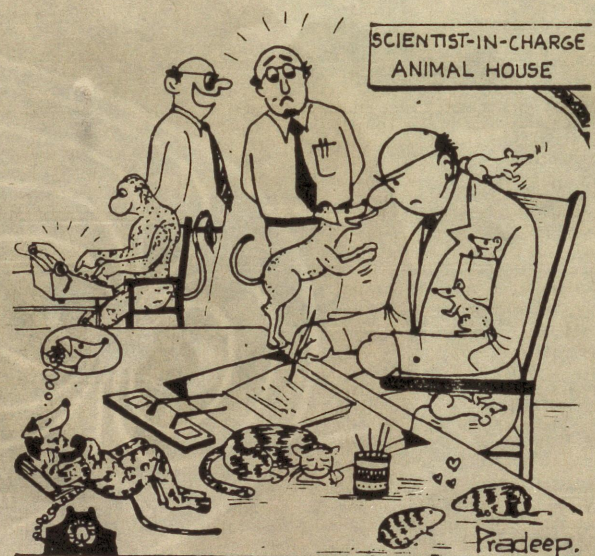
Why do we study the aurora? Is it only to satisfy the intellectual curiosity to understand the spectacular and beautiful patterns in the polar sky? No

doubt, the understanding of physical processes involved has enriched the subject of space physics, but these studies have practical applications also. In this space age, we know that there are many man-made satellites orbiting the Earth. During high auroral activity, radio and radar waves are frequently distorted or absorbed (cannot propagate) because radio waves propagate over long distances by bouncing off the ionosphere. The auroral discharge can give false commands to a satellite orbiting in the area of the aurora. At least one satellite has been known to have been lost due to such an event. The electrical storms can also produce surges of electric current in power lines that is known to result in power failures. The study of auroras therefore plays an important role in our understanding of the effects of natural phenomena on man-made systems on the earth.

Professor Uberoi is with the Department of Mathematics, Indian Institute of Science, Bangalore



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Author's Bio-Data

- B E, BITS Pilani. M Tech, IIT Kharagpur. Prestigious NTS scholar. Rank 5 in High School Raj board (95% in Physics, Chem, Math).
- World-famous author. Published 3 books in USA including best selling book "Tricks of MS-DOS Masters", 721 pages, \$27.95.
- Increased my reading speed from 72 words to as fast as 1037 words per minute.
- First engineering job paid only Rs 1000 per MONTH. Finally, earned \$50 (Rs 1500) per HOUR in USA as computer expert and writer.
- At the peak of success, I left USA and returned to India. To share my mind power study techniques.
- Expert in computers, mind power, and study techniques. Was a member of the Society for Accelerated Learning & Teaching, USA.
- Learnt No-Mind meditation of Osho, TM of Mahesh Yogi, Hi-tech meditation of Brother Charles, etc.

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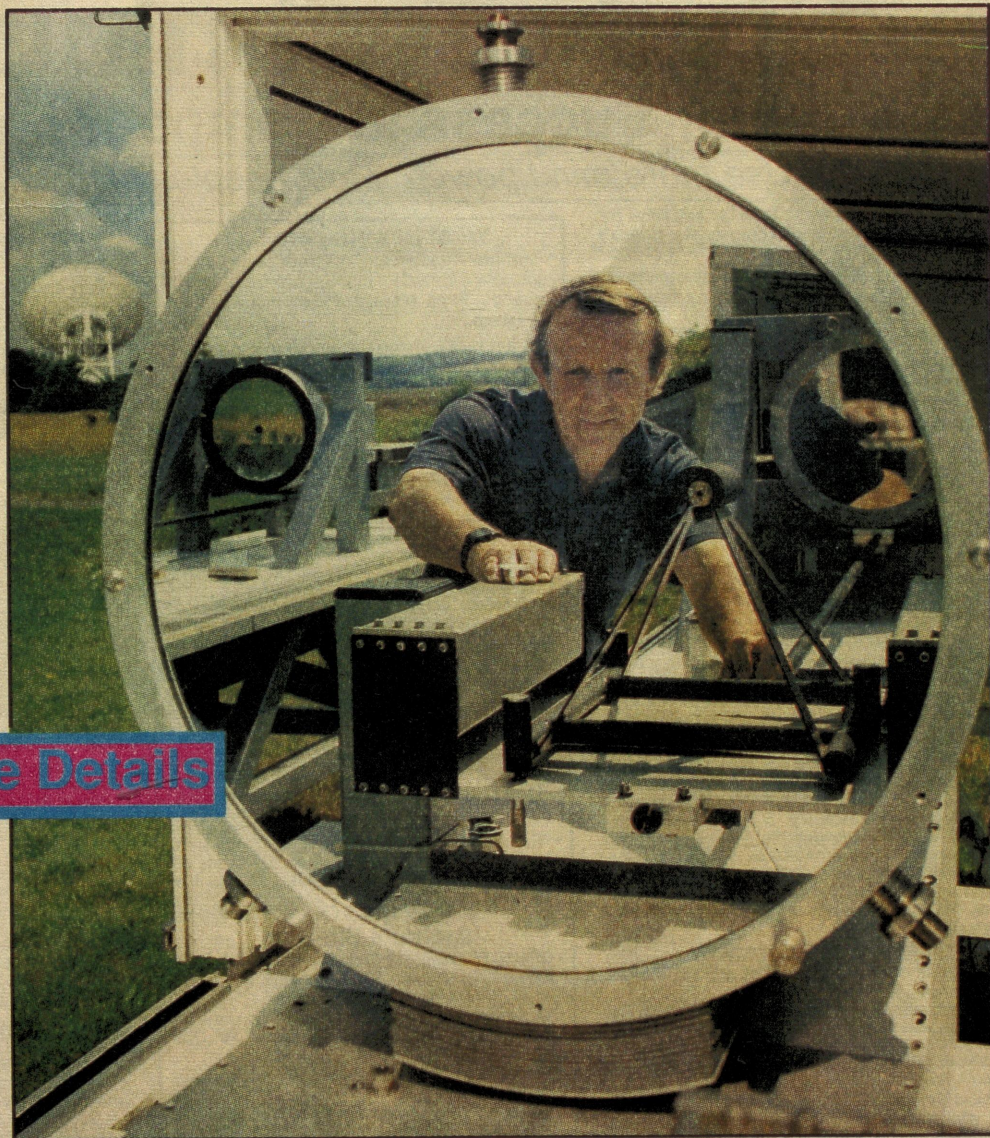
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Putting Fine Details

Into Stars

SCIENTISTS are planning to use an established radio telescope technique of combining signals from a series of linked telescopes to obtain the best-ever ground-based picture of

the stars which promise to reveal stars in one thousand times more detail than has yet been possible.

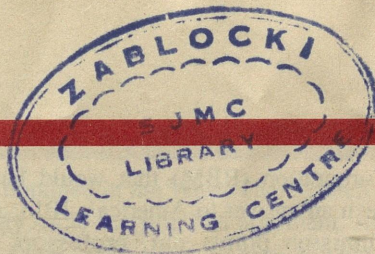
This will be achieved by a new instrument known as the Cambridge Optical Aperture Synthesis Telescope (COAST). It can combine the starlight collected by four 50-cm telescopes in a way that simulates the resolving power of a giant 100 metres diameter telescope.

The ability of any telescope to resolve fine detail is related to the size of its mirror or dish and the minimum wave-length of radiation it is looking at. Because radio waves are a million times

longer than light waves, radio astronomers developed what is known as 'aperture synthesis' using spaced-out dishes to simulate a much bigger telescope. In this way they were able to make radiomaps of the sky with the sort of detail obtained with optical telescopes. Now, the aim is to apply the same technique to optical telescopes to make it possible to build up pictures of the sky at visible wavelengths with unprecedented detail. The light signals are coded so that the effects caused by turbulence in the atmosphere can be separated from the real details of the stars and galaxies under study.

When fully operational, COAST should be showing up details such as sunspots and other spots on nearby stars, and how hot gas is shot from the surface of violently active variable stars. Stars that have planetary systems around them will be another target of particular interest. The exceptional high resolving power of COAST should make it possible to detect small regular 'wobbles' in the position of a star that would reveal the presence of planets. It will also help astronomers to solve some current puzzles such as the nature of the central regions of active galaxies.

(London Pictures Service)



SELLING RESEARCH

THE INDIAN SCENE

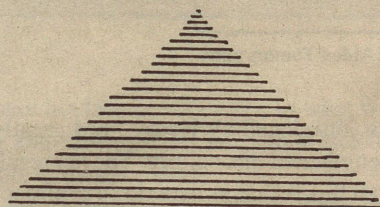


SCIENCE can be regarded as an enquiry into natural phenomena without any concern or interest in the commercial exploitation of the result of the research. Technology is the end-product of science, and its development is almost invariably linked to the commercial angle. Science is the fountain-head from which technology flows. To cite a classic example, Michael Faraday discovered the laws of electromagnetic induction; this is science. Faraday's laws are used for designing the electric motor; that is technology.

Usually it is scientific discoveries that drive technology. But it is also possible for technology to spur science. The use of computers in modern day research furnishes the best example of this reverse flow.

Technology has invaded all aspects of modern society be it agriculture or medicine or defence. People are aware that in the recent Gulf war, victory went to the side with superior technology. If India is to be a modern nation, it has no

Despite being rich in resources and skilled manpower, India still lags behind in the technology race. G. VENKATARAMAN examines



option but to accept and adopt technology in a proper measure. Since technology is born out of science, India also needs science. I stress this because, it is often argued that India needs only technology and could do without scientific research. This is utter nonsense. The supporters of this argument would cite the example of Japan in this context — in a somewhat distorted manner I must say. It is said that Japan exploits the research findings made in other countries to develop technology. May be, but lately this sponging is not working out too well because America has begun insisting that Japan too invest in basic research. The threat held out is that otherwise Japan would be denied access to research information. Japan is responding and has begun to make sizable investments in basic research. As a result, the universities in Japan have begun to benefit.

If Japan has been trying so far to promote technology without spending on science, Britain has been doing just the opposite. It was spending quite a bit

of money on research without worrying too much about the generation of technology — that is, until a few years ago. Now things have taken a dramatic turn.

In the early sixties, computer scientists in the University of Manchester built a very advanced type of computer which they named Atlas. This atlas was such a terrific machine that everyone expected it would result in a

Corporation (BBM) that would have been an answer to America's IBM. As Finniston points out, professors in America are made of different stuff. From the days of the Pilgrim Fathers, labour was always in short supply in America and that country always went for mechanisation in a big way. There were gadgets everywhere and people grew up surrounded by them and tinkering with them. The automobile revolu-

tion about providing consultation to industry, offering knowhow, etc. Parenthetically, it may be added that our academics are more like the British than the Americans.

The evolution of technology from science thus depends to a large extent on the values prevailing in society. A concrete example of the complex chain involved in the transformation of science into technology is the case of

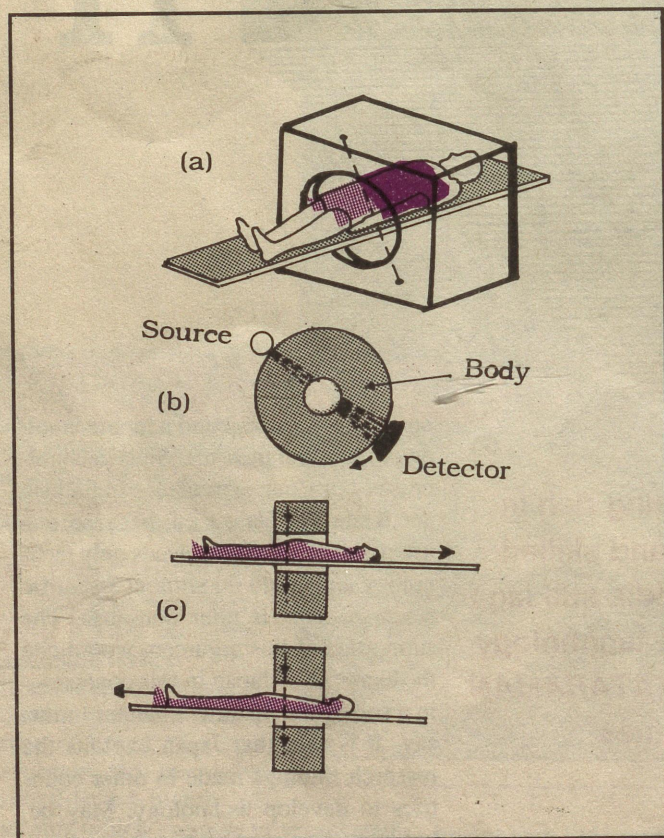


Fig. 1. General scheme of functioning of a Computer Aided Tomography

thriving computer industry in the U.K. and that Britain would sweep the world market. Nothing like that ever happened. A well-known metallurgist named Monty Finniston has explained why. He said that this failure occurred because British professors did not know how to sell their ideas and how to transfer technology to industry. And so Britain missed the golden chance of coming up with a British Business Machines

Corporation introduced by Henry Ford greatly strengthened this culture. The net result of all this is that in America a professor might be doing research on an abstract subject like differential geometry but at the same time he knows how to fix his car or the plumbing at home. Thanks to all this, he has a healthy respect for an appreciation of technology. He also understands the importance of technology for America and has no hang-ups

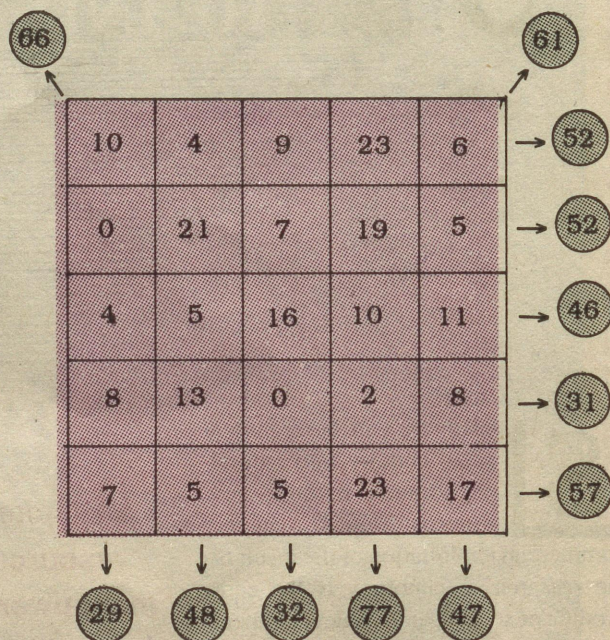


Fig. 2. The mathematical strategy similar to the one used for constructing CAT

CAT or Computer Aided Tomography, a well-known medical diagnostic tool.

An X-ray source-cum-detector combination is rapidly rotated around the patient and data are recorded. The data are then processed to construct the image of the corresponding section of the patient's body. The problem of inverting the observed data to reconstruct the required image is similar to the following mathematical problem.

Fig. 2 shows a matrix of numbers. In circles are the sums along various directions. The question may now be asked: "Given the numbers in the circles, is there a method for reconstructing the matrix?" The answer is: "Yes". Roughly

the same strategy is used in reconstructing images of organs using scanning techniques. This method of scanning the interior is called tomography. The inputs needed from various disciplines in order to realise CAT are shown in Fig. 3. Obviously, no single specialist could have developed a CAT machine; it has become possible on account of inter-disciplinary team work. This is a key point.

THE chemistry for transforming science into technology is a rather complex one and directly related to the environment prevailing in the society concerned. America is a country with the right climate for innovation. It is no wonder therefore that most of the technological breakthroughs have come from that country, especially in the post-war era. Examples of such innova-

are obtained in the West. There is definitely some merit in this argument. At the same time, there is also a widespread feeling that we are getting very little for what we spend. This also is true. Indeed there is a lot of frustration in the scientific and technological community about not being able to get on with the job and achieve things; indeed this is one of the several factors contributing to brain drain.

Some of problems in generating vigorous scientific research and a thriving technology as I see, are that we have spread ourselves too thin in research, we lack focus, a structured approach, an "operating system", or a proper mechanism for the transfer of technology. We have failed to encourage engineers and technicians to seek self-employment, and have encouraged bureaucracy and allowed licence-permit Raj to flourish.

few weeks later the entrepreneur came running back to the lab screaming about the high cost of the process. Why the complaint? Because the scientist during his R & D had used what are called analar grade chemicals, that is, high-purity chemicals. These are commonly available in the lab and it is not surprising that the scientist used them. And while transferring the knowhow, he had told the manufacturer to use analar grade chemicals. But they are very expensive and as a result the process became uneconomical. The failure in this case is that the lab had not appreciated the need to develop an economically viable process and field test it before marketing. We have talked about a structured approach. What is the structure required for transfer of technology. Fig. 5 shows a possibility.

Very few of our labs, if at all, go

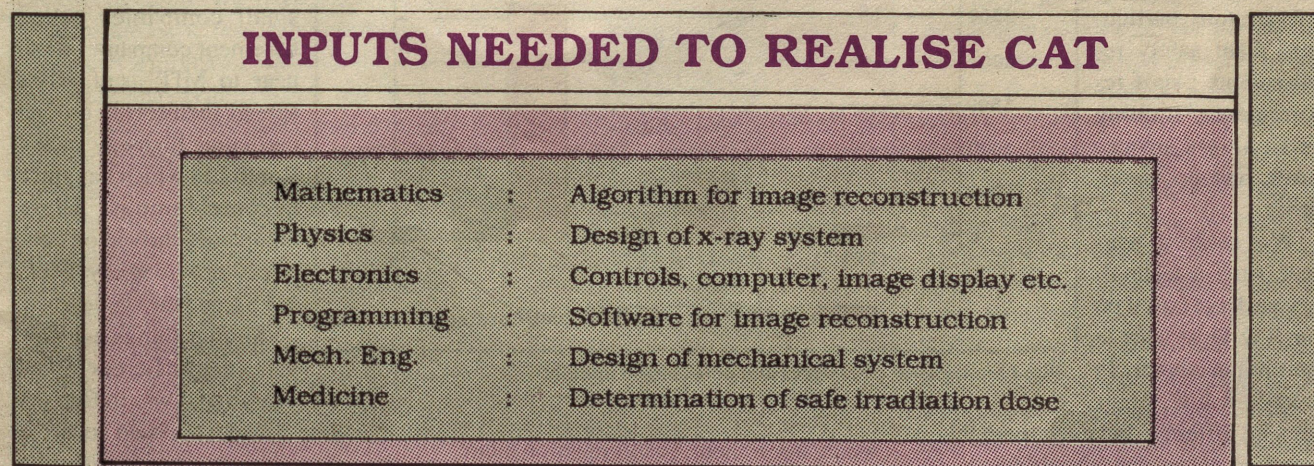


Fig. 3. CAT is a child of many sciences

tions include : CAT, the Polaroid camera, the laser, the chip, the personal computer, the xerox machine and satellite communication.

Let us now turn to the Indian scene. As one can see from Fig. 4 we are pumping in a lot of money into research and development. Of course it is nowhere near what the advanced countries are spending and that is why our scientists often say that public should not expect the same kind of results as

There is a lack of coherence in what we do, and, above all, there is a total lack of faith in things Indian.

Let me illustrate some of these remarks with a few examples. I shall start with the lack of structured approach. A scientist in one of our national labs once developed a process for coating phosphors on TV picture tubes. The knowhow was later transferred to an entrepreneur through National Research Development Corporation (NRDC). A

through a scheme like this. May be it is too much for one lab to do all this, in which case we must have a chain of sister labs working in tandem for this purpose. This is precisely what the chain of labs in the old Bell labs network used to do. Nothing like this ever happens in India. Instead, the scientist is expected to make a discovery, find an application, then develop a process or a product, find a customer for the product/process, transfer knowhow, help the

customer establish production, help him with training, and so on. This is not only impossible but also absolutely ridiculous.

Over the years, our industry has become very allergic to local knowhow and has started importing technology in a big way. Thus we often have the funny situation where a newspaper carries a report about a scientist receiving an award for developing some product, and the same newspaper carries on another page a report about some company importing knowhow for the same product. When industry imports technology, it gets what is called a technology package. The package includes :

process flowsheet; process details; list of equipment required, their specifications, cost, and supplier particulars; plant layout; infrastructure particulars; plant safety requirements : staff requirements, training particulars, procedures, and documentation.

We seldom produce such a technology package based on our R & D, at least in the civilian sector. In defence R & D, things are a bit different but even there things are often not as they should be.

Let me now turn to an even more serious malady — the lack of faith in things Indian. May be there are good reasons, but in general everyone seems to distrust things Indian. There is in fact a well-defined chain of distrust. We can see this by considering an example. Suppose the Army wants a product and say the Defence R & D offers to design the product. Here is how the "foreign bug" operates :

Designer : *"Let me try an original design."*

Systems engineer : *"No, copy a foreign design."*

Systems engineer : *"Use local materials."*

Shop engineer : *"I want imported materials."*

Lab : *"Use our knowhow."*

Production agency : *"We want imported knowhow."*

Production agency : *"Use our product."*

Army : *"We want an imported product."*

So one can see how this chain of distrust propagates !

SOMEWHERE between 1947 and 1992, things went wrong, in fact a

so let me briefly amplify. Take the example of the famous company Hewlett and Packard. Hewlett and Packard were two engineers working in the Stanford University, USA, immediately after the war. They were helping with the design of various accelerators in the University. After a while, they both left to form their own company, to make products using the skills they had acquired while working in the University. The University encouraged them by placing orders, and asked them to do various development works. The company began to prosper and soon began to supply to various other customers including the US defence establishment. The same

thing happened on the east coast of U.S.A. Many engineers and graduates who came out of the famous MIT (Massachusetts Institute of Technology), set up small companies called basement companies quite near to MIT itself. They spread themselves on one particular highway called Route 128 which has since become famous. These companies thrived on contracts provided by MIT, NASA and the US defence.

Similar things are now happening in Europe. Some years ago, I was in Europe.

At that time I was supposed to be in charge of an accelerator programme and in Italy I met a chemist with a Ph.D. who had founded a company for making accelerator parts. This person was not trained in accelerator engineering or physics. yet he had got into that business and was thriving by supplying to customers all over Europe and America. I know many engineers in India who are capable of such activities. But our system has stifled them. And so, young graduates have been scared away from self employment. Result ? A sizeable fraction of the good ones have gone off to other countries. Most of the

EXPENDITURE ON RESEARCH AND DEVELOPMENT IN INDIA

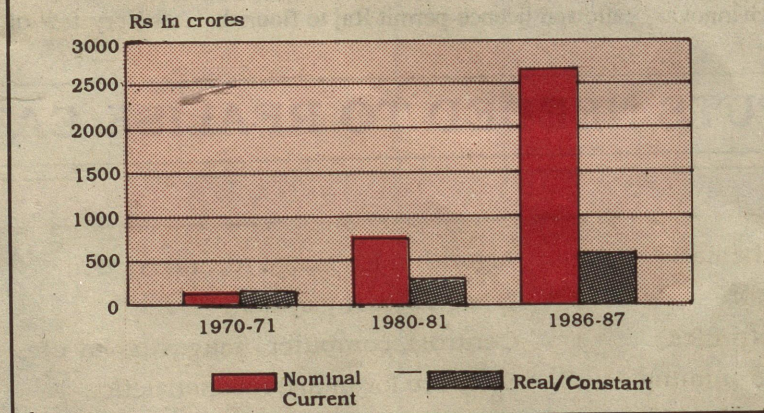


Fig. 4 Money spent on research and development in India

whole list of them. I can't mention them all but here is a partial list.

- Failure to invest enough on education
- Failure to teach problem solving
- Failure to keep educational establishments free from bureaucracy and politics
- Failure to encourage and support merit
- Failure to encourage proper work ethics, and
- Failure to encourage engineers to turn entrepreneurs.

This last point is very important, and

good ones who have remained have taken to management because it is highly paying. And they end up selling soap and toothpaste !

Is there nothing we can do about all this ? Well, there is but it requires a lot of will, political will especially, because we have to first undo many wrong policies. And everyone knows how difficult that is. In the meanwhile there are many things we can and should do without waiting for the Government, but all this is so difficult that only a rash and crazy person would attempt something.

First and foremost, research in our Universities must be strengthened. Secondly, we must abandon, as the British have successfully done, the notion that research must be always abstract and unrelated to national technological goals. In the name of so-called academic freedom, we have let a lot of fourth-rate basic research proliferate. I once met a professor who told me, "we do work that is interesting but is not useful: you do work that is useful but is not interesting. How can we ever work together ?"

This cannot go on. We must make our universities to work in close association with our R & D establishments on the one hand and our industry on the other. The other two agencies must also realise their respective responsibilities and learn to adapt themselves. We must have academia-industry-government consortia such as are becoming common in other countries.

Let me give just one sample: the triangular arrangement exists between state of California, the University of California (all its campuses) and American industry, particularly, California-based. The University undertakes research in electronics and in computers such as needed by the industry. Proposals are duly screened as usual. Selected proposals receive funding from the industry; the State gives an equal grant. Industry benefits, prospers, generates wealth and additional employment and

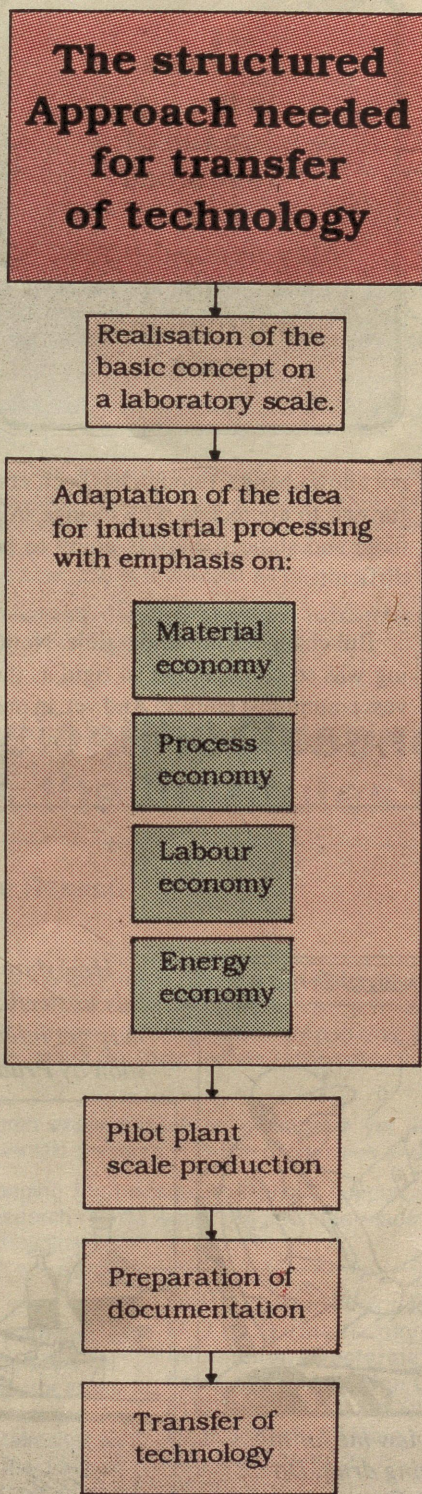


Fig. 5. Only a structural approach can help sell a research finding

the whole thing is a self-sustaining cycle.

On one occasion, I tried to get the Physics Department in one of our leading universities to take some interest in leading Defence R & D lab. But the scientists were simply not interested. They would rather collaborate with people in Poland and Cambridge !

There is also another question, namely, that of our becoming a global player. Nobody in his senses would say that India should become withdrawn and look purely inwards. That is impossible not only because of our country's size but also on account of our strategic geographical location. We definitely have a role to play in the international scene. The question is : who will define that role for us ? You would jump and say that obviously we have to define that role ourselves, but things are not that simple. That is so because however we are at present weak economically and fragile politically. The net result is that someone is quietly deciding what is "good" for us or what is "necessary" for us.

As a part of the slogan that we must go global, we hear the advice : "Do not try to make everything yourself. Do what you can and import what you cannot." Seems like sound advice and so let us accept it and say, "We cannot make a Cray computer and so let us import it." The Indian Institute of Science has been trying to do this for the past six years but without any success. If Germany or Japan wants a Cray, they get it the moment the order is placed. Suppose an Indian company imports computer technology. Do you think it can freely sell its products ? Not if the technology is sophisticated. Example: ECIL cannot sell a Medha computer to its own parent department !

Our semiconductor factory in Chandigarh got burnt down a few years ago. We are all recommending that they rebuild with modern equipment. This equipment has to come from Japan or the US, and they have decided that 3-micron technology is good enough for

us though the state-of-the-art today is 0.8 micron or even less. It does not matter if we are prepared to pay good dollars for what we buy. Somebody else has to decide that 1 micron technology would make us powerful. Should we accept it ?

India is too big, too full of resources both human and otherwise, and with too hoary a tradition to play second fiddle and a minor role in the international arena. We have to be global players but on *OUR* terms. We cannot afford to be a minor cog in somebody else's scheme of things.

Attention has already been drawn to the various advantages we enjoy compared to Japan. And yet we remain backward. It is almost as if there is a curse on us. This explanation would wash if we lived in ancient times; today it does not. We are unable to change because we are not allowed to. There are powerful vested interests which dare

**“India
is too big,
too full of
resources
to
play second fiddle
in
international
arena”.**

not allow change. Enough has been said for one to appreciate why change in a huge and static society is going to be difficult.

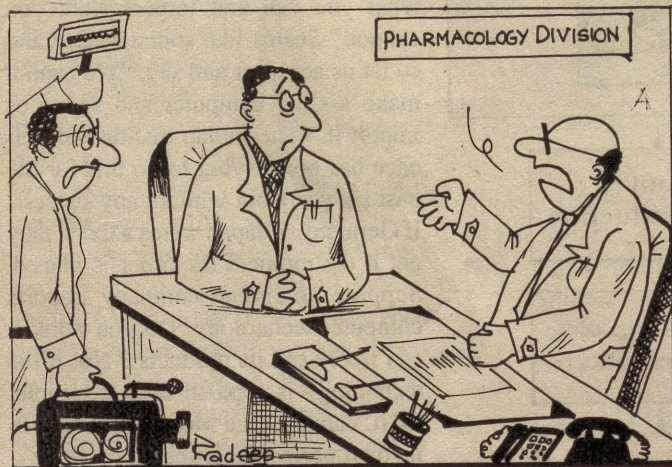
But change is not impossible. Nothing was so colossal and so rigid as the vast communist empire. And yet, in one short year, it has crumbled and has

disappeared into history books. The message is that if people desperately want a change there really will be a change for the better.

India means you and me. Do we really want India to change, and if so are we ready to work for it ? I don't know. Meanwhile I continue to wonder like the great physicist S.N. Bose did at the end of his Krishnan Memorial Lecture. He said:

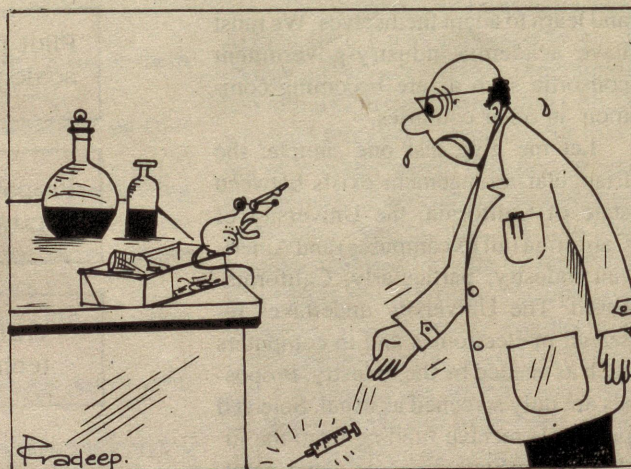
“It is a perpetual challenge to the Indian genius as to how, even though the country is endowed with such natural resources, even though the country has had such a brilliant history, why it continues to remain third rate in spite of so many resources and so much manpower.”

Excerpted from a talk delivered by the author at the Utkal University, Bhubaneswar, on 15 April 1992. Dr. Venkataraman is the Director, ANURAG, Hyderabad.



“...No, No! He has come to interview me for my discovery of a new memory improving drug. Do you remember anything about it?” (Cartoon by Pradeep Srivastava)

“How dare you want to give me injection with this unsterilized syringe! Don't you know that I may get infection and may be even AIDS?” (Cartoon by Pradeep Srivastava)



The Treatise on Indian Medicinal Plants

Editors: Asima Chatterjee and Satyesh Chandra Pakrashi

Pages: 172

Price: Rs. 250/-

Ayurveda, the indigenous system of medicine, advocates the application of various Indian herbs in curing many maladies. Several drugs of plant origin are used in Ayurveda.

The Treatise on Indian Medicinal Plants, Vol. I, the first in a series of six volumes, covers 111 plants. The write-up on each plant includes its vernacular name, occurrence and distribution, botanical description, and therapeutic uses along with important chemical constituents of the plant extract. A distinctive feature of the book is inclusion of authentic Sanskrit *slokas*, both in Devnagri and Roman scripts. The *slokas* explain the therapeutic uses of individual-plants. A glossary gives the meanings of Sanskrit/Ayurvedic and medical terms. Also, a list of books referred to has been given for ready reference.

The book is profusely illustrated with both coloured and black and white pictures to enable proper identification of plant species.

The editors of the book are eminent scientists in the field. Professor Chatterjee, a Padma Bhushan and a winner of the S.S. Bhatnagar Award, is a chemist of world repute. She is currently the coordinator of the Centre of Advanced Studies on Natural Products, Department of Pure Chemistry, Calcutta University. Dr Pakrashi, the former Director of Indian Institute of Chemical Biology, Calcutta and a Fellow of the Indian National Science Academy is at present a Distinguished CSIR Fellow.

This volume would prove immensely useful to teachers, researchers and specialists in the field of Ayurveda and medicinal plants.

Insight into Scientific Research in Indian Universities & the Institutes of Technology

Rais Ahmed and Madhulika Rakesh

Pages : v + 155

Price : Rs 140/-

The role of scientific research in industry, trade, defence and in the day-to-day life of an individual cannot be over-emphasized. It, therefore, becomes pertinent to take a holistic view not only of the various parameters of research but also to assess its organizational patterns, and human relations, values and attitudes associated with it, which are the main factors responsible for the germination and growth of research *per se*.

Insight into Scientific Research encompasses an exhaustive yet interesting study of the quality, character and efficiency of scientific research in Indian universities and other research institutions.

Several recommendations ranging from adequate financial support, reform of education leading to research, and utilization of research results would enlighten the reader. The book also throws light on what should be the research policy for Indian universities and research institutions.

One of the authors, Professor Ahmed, a Padma Bhushan is a renowned physicist. At present he is Executive Director of the Tertiary Education Commission in Mauritius. The coauthor Ms. Rakesh is an experienced researcher in the field of investigating conditions, process and value systems of scientific research.

Order for the books should be accompanied by M.O./D.D. made payable to "**Publications & Information Directorate**" and sent to:
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Well illustrated with graphs and tables, which aid the text, the book should be a valuable possession for all involved in the scientific and technological development of the country.

Blood-Glue

Not only do surgeons have to be skilled with their hands, they also have to be fairly inventive. They have borrowed tools, such as saws, screw-drivers, planes, drills and chisels from all kinds of trades, and moreover, have often devised their own specialised tools or new applications for existing materials from other technologies. This is how surgical "adhesives" came into being.

With the arrival of the industrial era, increasingly efficient, fast and irreversible chemical adhesives were developed. Surgeons realised that such products could spare them having to use delicate and complicated stitches or ligatures, but the human organism re-

jected these foreign substances.

Research everywhere in the world then explored the area of biology. It had been noticed that fibrinogen, which is a part of blood plasma could, in certain circumstances, bring about adhesion between tissues (pneumothorax, peritonitis and in surgery).

The idea was taken up, studied, analysed, confirmed and finally carried out on a practical level by Bio-Transfusion and by the French National Blood Transfusion Centre as a novel surgical adhesive.

This adhesive comes in two separate syringes, just like the ones that come in two tubes in "do-it-yourself" stores. One of them contains the different freeze-dried elements causing human

blood clotting and the other contains thrombine, which is the other element used in blood-clotting. Combining the two products causes the formation of fibrinogen. An important fact is that this adhesive, made of human proteins, does not present any compatibility problems.

Its uses are obvious : in all cases when stitches need to be reinforced, when complete air or water-tightness needs to be ensured, or, more simply, every time bleeding has to be stemmed. Its field of application is thus vast and there are few areas of surgery in which it does not contribute an extra measure of security.

CEDUST

Snake Venom Stops Thrombosis

Worried over ever increasing occurrence of thrombosis in the world efforts are being made to fight the disease in several ways. Thrombosis is the occurrence of blood clots inside blood vessels. It may often result in serious heart maladies. A snake venom protein called echistatin holds the promise of being a potent weapon against

thrombosis. It is a protein present in the venom of the saw-scaled viper snake *Echinus carinatus*. It is a potent inhibitor of platelet aggregation, which is the beginning of a clot.

American researchers Yuan Chen, Steven M. Pitzenger, Victor M. Garsky, Patricia K. Lumma, Gautam Sanyal and Jean Braum of the Chemis-

try Department, Rutgers University and Department of medicinal Chemistry and Pharmaceutical Research of Pennsylvania carried out proton nuclear magnetic resonance (NMR) spectrum analyses to know what turns these proteins to be inhibitors of platelet aggregation. The researchers have established the structure of the protein that is capable of inhibiting thrombosis.

P.C. Bhattacharyya

Electronic Wallet

To live without cash will soon be possible. This year, the French Post Office is launching an electronic 'wallet' which serves to settle all purchases (including a little cup of coffee) with a smart card, a new step in the monetary field.

The 'electronic wallet' is in fact a telephone unit card improved upon in two fundamental aspects. It is rechargeable, and can be used in all commercial establishments that adhere to the system. In real terms, the holder credits his electronic wallet with a cheque, a bank

credit card or cash. The amount, recorded by the chip, diminishes as per the purchases, until it is totally exhausted and no further purchase is possible.

Parallely, the commercial establishment's account is credited in a few hours. They are therefore certain of being paid, as the card can only be debited if it has sufficient funds. Moreover, they no longer have to deal with liquid money.

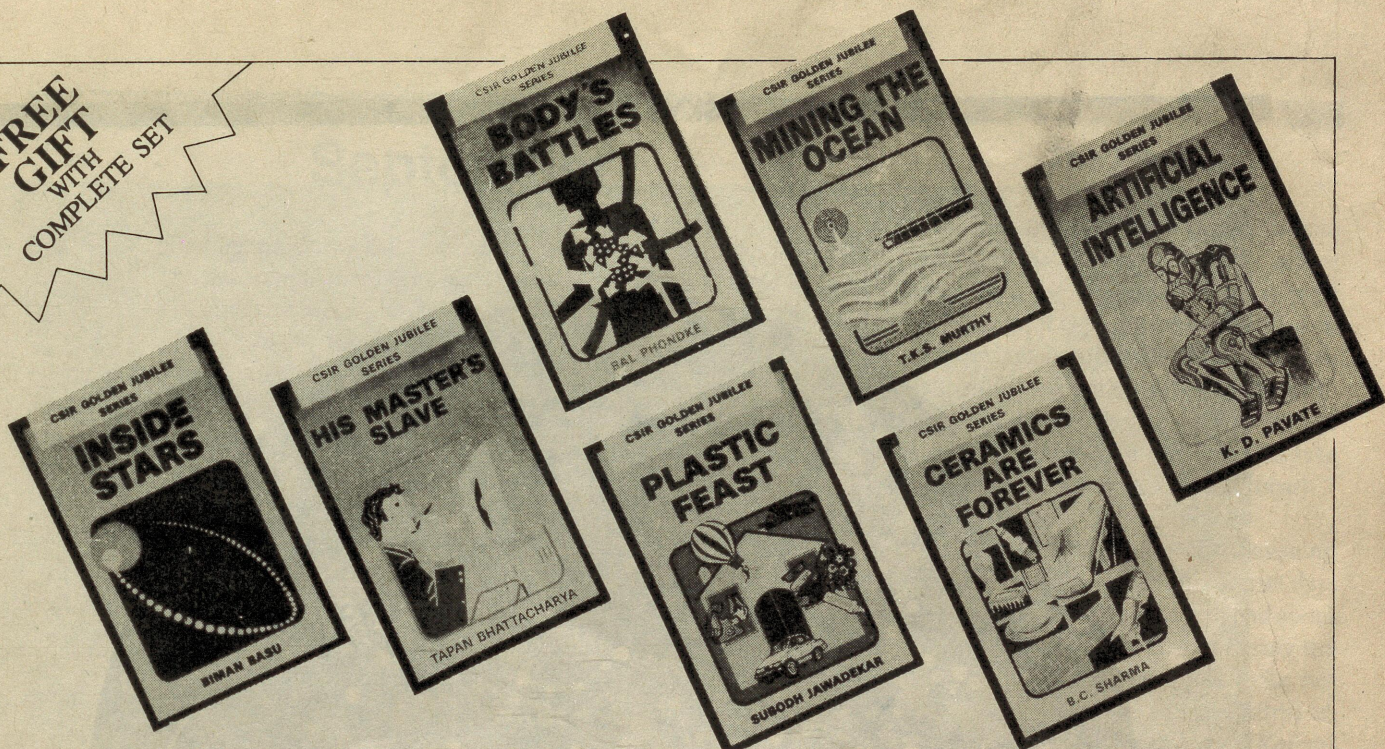
For banks, these automatic transactions are a major economising factor (in

France, clearing a cheque costs the equivalent of Rs.25 on an average). Moreover, they will touch a commission (not yet fixed on the transactions). Finally, the client's account will be debited the day he charges his card, even if he does not use it until a month later.

Originally meant only for payment of fees related to sport activities mechanical lifts, hiring of skis, excursions, etc. the system was extended 18 months later to the station shops. Today 150 reading machines are installed in the commercial establishments.

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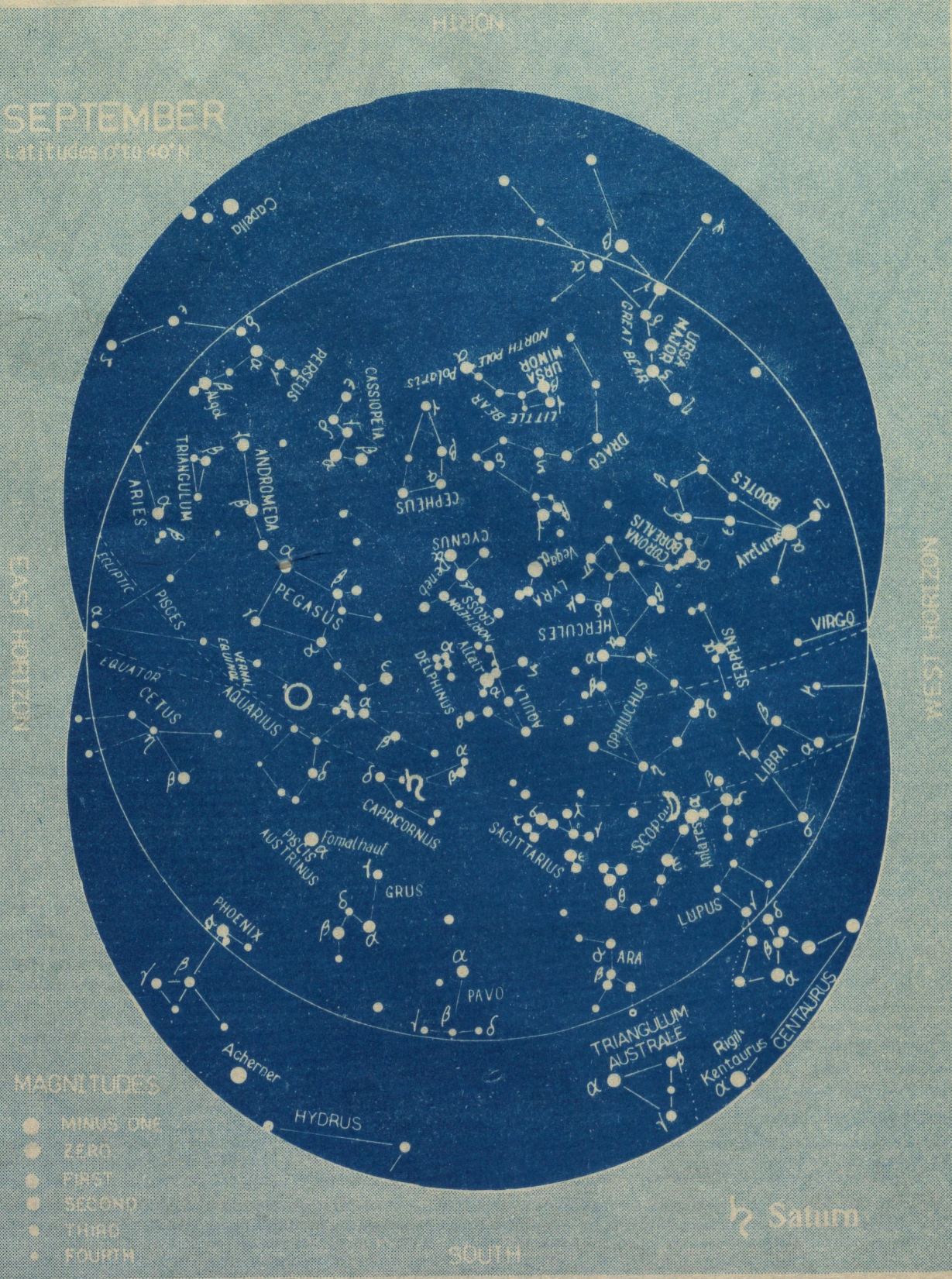
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SEPTEMBER

Latitudes 0° to 40°N



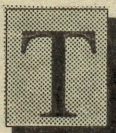
MAGNITUDES

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

♄ Saturn

September

The Planets



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 the 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 the 16th September it can be used on the 17th at 8-26 pm and on the 15th at 8-34 pm. In the same way it can be used for other months; for the 16th August it is for 10-30 pm and for the 16th October 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.

Mercury (Budha), visible in the morning sky rises about an hour before sunrise at the beginning of the month. Thereafter it comes too close to the Sun to be visible during the month being in superior conjunction with it on the 15th. It passes about a degree north of the star Regulus (*Magha*) on the 3rd. It moves from Leo (*Simha*) to Virgo (*Kanya*).

Venus (Sukra) visible in the evening sky sets about an hour after sunset during the first half of the month and about one and a half hours after it during the second half. It passes about three degrees north of the star Spica (*Chitra*) on the 19th. It moves from Virgo (*Kanya*) to Libra (*Tula*). Its visual magnitude is about -3.9.

Mars (Mangala), visible in the morning sky rises about half an hour before local midnight during the first half of the month and about an hour before it during the second half. It moves from Taurus (*Vrisha*) to Gemini (*Mithuna*). Its visual magnitude is about +0.5.

Jupiter (Brihaspati), visible in the evening sky sets about half an hour after sunset at the beginning of the month. Thereafter it comes too close to the Sun to be visible being in conjunction with the Sun on the 18th. It moves from Leo (*Simha*) to Virgo (*Kanya*).

Saturn (Sani), visible in the evening sky sets about three hours after local midnight during the first half of the month and about two hours after it during the second half. It is in Capricornus (*Makara*). Its visual magnitude is about +0.4.

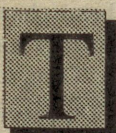
(Source : Positional Astronomy Centre, India Meteorological Department New Alipore, Calcutta-700 053)

Planetary Positions for September 1992

Date	1st		10th		20th	
	R.A.	Decln.	R.A.	Decln.	R.A.	Decln.
Mercury	9h 54m	14.3N	10h 59m	8.4N	12h 07m	0.6N
Venus	12h 03m	0.9N	12h 43m	3.8S	13h 28m	8.8S
Mars	5h 31m	23.0N	5h 54m	23.3N	6 h 19m	23.5N
Jupiter	11h 30m	4.3N	11h 38m	3.6N	11h 45m	2.7N
Saturn	21h 05m	17.8S	21h 03m	18.0S	21h 01m	18.1S

Adopted from figures supplied by Positional Astronomy Centre, Calcutta

The Moon



THE full moon occurs on the 12th at 07-47 a.m and the new moon occurs on the 26th at 04-10 p.m. I.S.T.

The moon passes about five degrees north of Saturn on the 9th, one degree south of Mars on the 20th and about four degrees south of Venus on the 28th.

The moon is at apogee or farthest

from the Earth on the 10th and is at perigee or nearest to it on the 25th.

The lunar crescent becomes first visible after the new moon day in the evening of the 28th except in the extreme southern part of India, where it becomes visible on the 27th.

The Earth is in autumnal equinox on the 23rd.

SUNSPOTS

IS THE SUN'S CLOCK A PENDULUM?

The curious dark spots which appear with clocklike regularity on the sun have fascinated astronomers for centuries.

Sunspots have intrigued astronomers since Galileo first used a telescope to watch the motion of these curious blobs. He noticed that the sunspots were concentrated in belts lying at latitudes near the equator; and his observations helped him deduce that the Sun had an axis of rotation, on which it turned about once a lunar month.

In the middle of the last century, after 40 years of observing the Sun, the German astronomer Heinrich Schwabe showed that the sunspot numbers reached a maximum about every 10 years, and then declined.

At the same time, the English astronomer Richard Carrington observed that the sunspots worked their way from latitudes 20°-30°N and S to 5°-10°N and S, where they disappeared, over the 10 years from the start of a new cycle. Further, Carrington tracked the spots as they rotated around the Sun, showing that they did not all have the same period of revolution.

In particular, he saw that the closer

PHILIP R. GOODE

the spots came to the equator, the quicker they went around the Sun. That finding showed the Sun did not behave like a solid body, but had a rotation of less than 27 days near the equator and 40 days at the poles.

Carrington's discovery of differential rotation was one of the classic contributions of an amateur astronomer to the advancement of science. In a more detailed analysis of the sunspot recorded later in the 19th century, Rudolf Wolf, of Switzerland, concluded that the time from the start to maximum sunspot activity was on average closer to 11 years.

Then early in this century, the American astronomer George Ellery Hale showed that the sunspots were associated with strong magnetic fields. In his investigations, he developed an astronomical instrument that exploited a laboratory discovery made a few years be-

fore by Pieter Zeeman, the Dutch physicist. Zeeman found that when an intense magnetic field surrounds a source of light, it splits the light beam into an atomic spectra of elements of characteristic patterns.

In the first astronomical application of the Zeeman effect, Hale observed that light from sunspots, unlike other regions of the Sun's surface, showed the spectral pattern of Zeeman slitting. He also found that the sunspot tended to appear in pairs with opposite polarity, like the opposite ends of a bar magnet.

Further, in the first 11 years, spots of one polarity lead in the direction of rotation in the northern hemisphere, and those of the opposite polarity lead in the southern hemisphere. Then, for the next 11 years, the polarity of the leading spots is reversed; thus, a complete sunspot cycle lasts about 22 years.

It is commonly believed, with good reason, that a dynamo-type mechanism, provides an internal solar clock driving the activity seen on the surface.

In this explanation of solar activity,

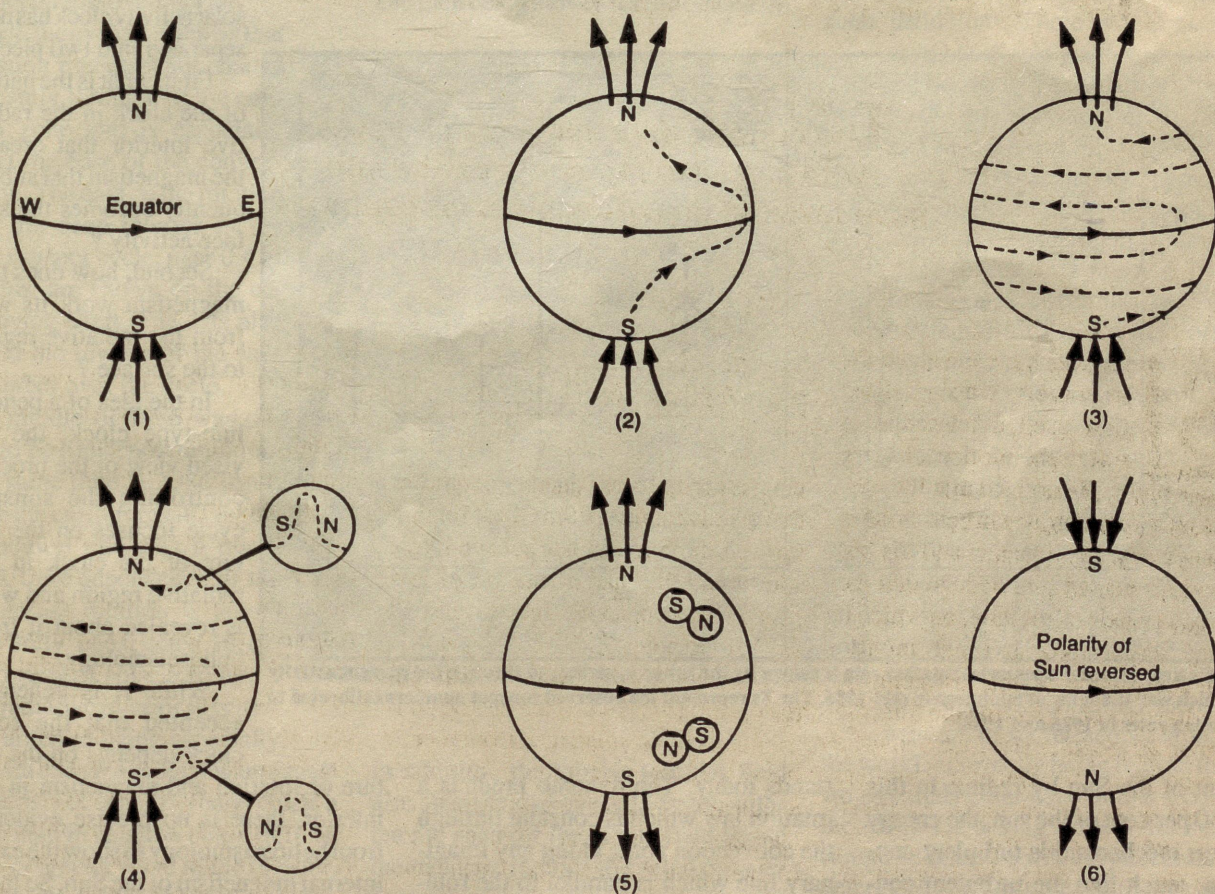
there is a weak dipole magnetic field inside the Sun; as though there is a bar magnet inside the Sun. While, of course, there is no bar magnet, the Sun's internal differential rotation shears this magnetic field, wrapping it tightly several times around the Sun. The wrapped field is usually called a toroidal magnetic field. The stretching and overlaying of the field lines intensifies the field and it becomes buoyant in this process; floating to the surface in toroidal tubes

solar surface, sunspot pairs are formed. Towards the end of the first 11 years of the cycle, the lagging polarities drift towards the poles and the Sun's magnetic field is reversed.

The shear of differential rotation comes into play again and tubes of magnetism of the opposite polarity are formed. So when these tubes erupt through the solar surface, the sunspot pairs are formed with the opposite polarity of those of the first half of the

dynamo reflects the deductions about the internal origin of activity based on nearly four centuries of observations of the solar surface. In the past few years, seismic analyses of the Sun's interior have shed new light on the activity clock. As in terrestrial seismology, sound waves are generated by starquakes and the characteristics of the sound waves are influenced as they pass through the interior of the star.

So each soundwave samples the in-



The elementary dynamo picture of the solar activity cycle is illustrated in six steps leading through 11 years of the 22 year cycle. The Sun is rotating from west to east. At stage (1) the dipole field is illustrated with its north and south poles. The rotation rate decreases with increasing latitude and is most rapid at the equator. Inside the Sun the field is "fixed" to the solar material and the differential causes the field lines shown by dotted lines to be stretched gradually, into a toroidal geometry, or tubes, as indicated in time steps (2) and (3). The toroidal fields have opposite senses in the northern and southern hemispheres. Stage (4) shows two toroidal loops erupting, becoming pairs of spots with opposite polarities leading in the two hemispheres. Stage (5) shows the two spot pairs of which the polarity of the lagging spots drifts toward the poles, causing a reversal of the polarity at the end of the first half of the cycle as illustrated in stage (6).

shaped like doughnuts.

Where the tubes erupt through the

cycle now leading in the direction of rotation. This simplified picture of the

terior in its characteristic way. And with a sufficient variety of soundwave

data, the temperature or rotation rate, in particular, may be inferred as a function of radius.

Of course, there are differences between terrestrial and solar seismologies. On one hand, sunquakes are continuously generated in the outermost turbulent regions of the solar interior. On the other hand, they cannot be "heard" by seismic listening devices but are seen by the blinking of the Sun. The recent knowledge about the Sun's internal rotation from the study of solar quakes shows that surface-like differential rotation occurs throughout the outer 30

Many researchers suspect that the entire volume beneath the convection zone rotates like a solid ball. Until recently, this seemed to be consistent with the seismic data. The region beneath the convection zone is the radiative interior; which earns its name because the energy transport mechanism is radiative transport. When a metal pipe is heated at one end, it becomes warm at the other end via radiative transport.

The helioseismic rotation law is simple, but it is consistent with that predicted by the dynamo picture as it

down as long as the activity cycle would require. The tubes would float to the surface in weeks rather than years.

In the last few years, the dynamo theorists used this to argue that the seat of this dynamo is near the base of the convection region (at about 0.7 of the radius). The seat of the dynamo should be in a region where the rotation rate is changing rapidly as a function of both radius and latitude. According to data from helioseismology, that describes the base of the convection zone and is consistent with dynamo theory.

But the problem of describing the solar activity clock has now separated into two pieces.

First, what is the nature of the clock in the radiative interior that creates the magnetism that subsequently becomes the surface activity?

Second, how does that magnetism work its way from the radiative region to the surface?

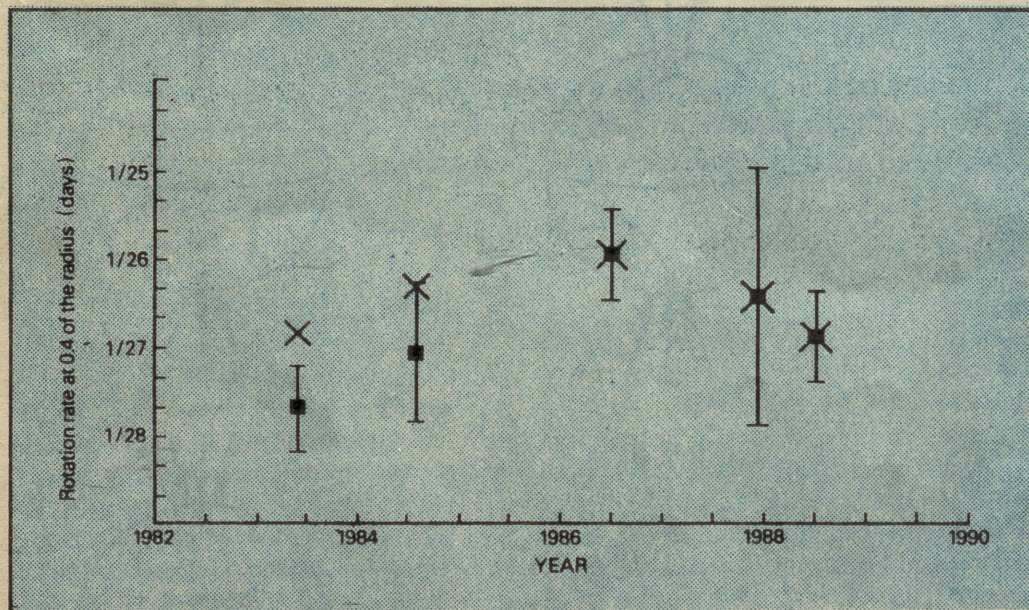
In the idea of a pendulum-type clock, the revised view of the process controlling the sunspot cycle focuses on the nature of the clock in the radiative region and what is revealed about it from helioseismology.

While it is generally accepted that the solar clock depends on the nature

of rotation and magnetism in the interior, there is no precise evidence from helioseismology to show the exact internal magnetism of the Sun. So there is still no direct measurement of the Sun's internal magnetism.

Yet, a clear picture of the Sun's internal rotation is disclosed by helioseismology. Indeed, there is sufficient seismic information to ask whether or not the rate of rotation has changed through the current sunspot cycle.

In the current cycle of activity



The Sun's deep internal equatorial rotation rate is shown by the squares, measured through the current activity cycle which was at a sunspot minimum in mid-1986. The Xs represent the observed sunspot numbers calibrated to the rotation rates in 1986 and 1988.

per cent of the Sun by radius. In this outer 30 per cent of the sun, the energy transport mechanism is turbulent convection, much like the turbulent convection that occurs in a coffee percolator. Near the bottom of the convective region in the Sun, there is a sharp transition to that of a body rotating with the characteristics of a solid with a period of about 27 days.

Thus, it seems fair to regard the volume just beneath the convection zone as a rotating solid shell.

stands today. The dynamo predicts a rotation law which is constant through the convection zone, along any imaginary line which is parallel to the rotation axis.

DURING the 1960's when the dynamo theory was under development, it was generally thought that the dynamo was distributed throughout the convection zone. However, such a dynamo would produce magnetic tubes that would be too buoyant to be held

Dr Wojciech Dziembowski and I determined the Sun's internal rotation rate from the seismic data of many observers. We concentrated on the equatorial plane because that is the region in which the rate can be most accurately determined.

After all, for any rotating sphere, the rotation gets easier to observe the further the area of study is from the line of sight of the axis of rotation. We found quite an unexpected result; namely, that the most significant correlation between rotation rate and sunspot cycle occurred in the deep radiative interior.

In fact, the evidence shows that the rotation rate does not change significantly throughout the convection zone and is especially stable at the base of the convection zone. The data on the rotation rate in the deep interior in the current sunspot cycle, near 0.4 of the radius, are shown on the accompanying chart. The data also indicated the inverse of the sunspot number over the cycle.

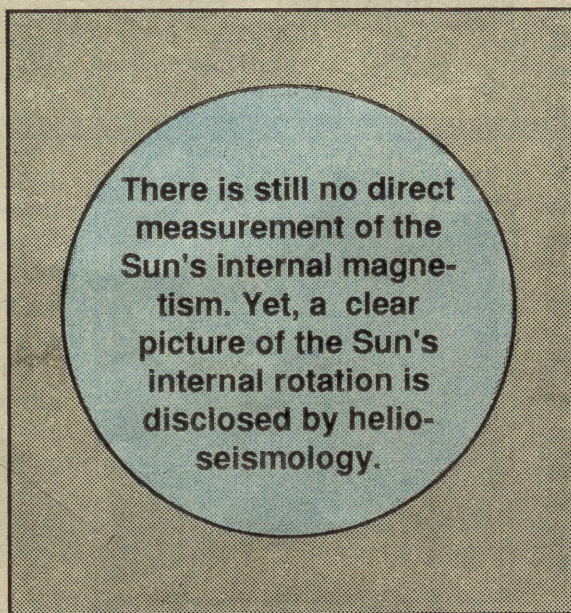
The middle of 1986 was observed to be a sunspot minimum. At that same time in 1986 itself, we have the curious result that the deep rotation rate was a maximum. A time dependence of the deep internal rotation is something wholly unexpected in the dynamo view of solar activity.

The radiative interior is generally regarded as being especially stable with changes occurring on a scale of millions not tens of years. Such a rapid change in rotation could only be due to a magnetic wave in the interior. This suggests a different origin for the solar clock; a torsional oscillation or a magnetic pendulum.

A laboratory example of a torsional pendulum would be a ball suspended north-south from a wire; and the ball is twisted, say, from east to west, and then released. Its subsequent west-to-east and then east-to-west, etc., motion would be that of a torsional pendulum.

For the torsional pendulum inside the Sun, there is a dipole magnetic field in the interior which forces an exchange of energy between rotation and the toroidal magnetism generated by the shear of differential rotation. The dipole field has a north-south orientation inside the Sun but the torsional motion is east-west.

At first glance, this picture resembles that of the dynamo; but in the pendulum scenario, the deep internal rotation has a differential component which changes sense with a 22 year period, being faster at low latitudes for one-half of the cycle and then being slower for the other half.



In addition, the tabular toroidal field also changes sign every 11 years, without the need for the dipole field inside the radiative interior to switch polarity correspondingly. That is, the shear of differential rotation wraps the magnetic field in one sense, say, east-to-west, for the first half of the cycle. Then the torsional motion reverses and the field is now wrapped in the opposite sense. Throughout all of this, the Sun's internal dipole magnetic field maintains the same polarity.

In the torsional motion, when the

toroidal field reaches maximum, some pieces of that field break away from the radiative interior into the convection zone and float to the surface from there. However, the pendulum continues with its 22-year period.

Torsional pendulum ideas have been suggested and discarded in the past. But they tried to allow for a dipole magnetic field throughout most of the Sun's interior and for that whole region of the inside of the Sun to be involved in the pendulum motion.

However, helioseismic results provide a different picture for the modern solar pendulum. There would be no sizeable dipole field in the convection zone. The turbulence there would quickly tangle such a field and cancel it out.

At the outer part of the radiative interior there would be a sizeable dipole field, roughly comparable to that in a sunspot. This field would stiffen the material, forcing the rotation rate to be time-independent there, and consistent with the helioseismic result. And this field could be maintained by a dynamo action like that shown in the illustration. Deeper down, the field would decrease sharply, allowing the rotation rate to vary with the cycle.

This alternative picture of solar activity is in the process of being developed. Certainly its basic tenets will be tested soon. A network of six telescopes around

the world is currently being built so that we can study solar oscillations around the clock for a long time. With such sunquake data, we will very accurately determine the Sun's deep internal rotation and its time-dependence. It could well be that, the correct picture of the solar clock is one in which it is a combination of a magnetic pendulum and dynamo. In a few years from now we will know the truth.

Reprinted from 'Spectrum', April-June 1992. Dr. Goode is with the Institute of Astronomy, University of Cambridge, United Kingdom.

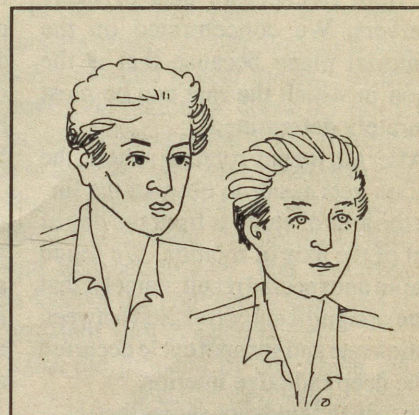
PRIZE WINNER

Why do some people have blue eyes while others have brown or black eyes ?

*Gaurav Gupta
Agra (U.P.)*

The colour of the eyes in humans is due to the presence of a pigmented layer of cells in the muscular screen, the iris, which is located just behind the transparent cornea. It allows only the right amount of the light needed to produce a sharp and clear image. When the pigment, the melanin, is absent the iris though transparent looks blue because the light passing through the fluid - the aqueous humour - behind it gets

scattered, producing an effect similar to the one making the sky look blue. If the concentration of melanin is more, it looks brownish and with more pigments becomes darker. The spread of pigments in this layer is a hereditary character. In some, the pigments may be sparser giving a blue colour to the eye. In others it could be denser and so the eye looks brown or black. Sometimes, the blue eyes in a baby can turn brown when it grows up. This happens because the iris cells accumulate more pigments as the boy grows up.



Kollegala Sharma

Why does the sky look blue from the earth and black from the moon ?

*Subhash Chandra Ojha
Patna (Bihar)*

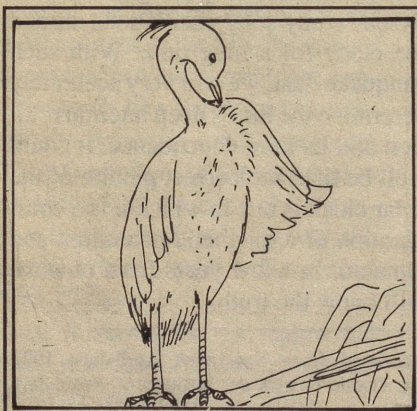
When sunlight reaches the earth's atmosphere, it hits molecules of air and dust suspended in air and gets scattered in many directions. Sunlight consists of light waves of varying wavelengths, each of which is seen as a different colour, and the wavelength decides the



amount of scattering of a particular colour. Blue and violet are scattered more than other colours. So during the day the sky appears blue because more blue light is deflected towards earth.

But on the moon there is no atmosphere, and although there are some ions there, the density is very less. As a result scattering of sunlight is negligible and so sky appears black from the moon.

Hasan Jawaid Khan



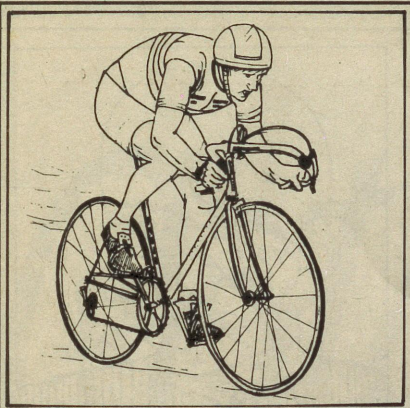
Why do birds preen their feathers ?

*Arundhati P. Bhosale,
Bombay (Maharashtra)*

A bird cares for its feathers chiefly by cleaning and smoothing with its beak, called preening. It uses its feet to preen its head and other hard to reach parts. Preening is essential to keep the feathers dry. The fine structures of the feathers—the barbs and barbules—are interlocked with each other to prevent the

entry of water. After a flight the precise geometrical relationship between the barbs and barbules gets disturbed. While preening, the barbs and barbules are nibbled back into the interlocking position. Water birds such as geese and ducks also apply some oily substance on the feathers during preening to keep them water repellent.

Hasan Jawaid Khan



Why should a cyclist pedal harder in the beginning than when the bicycle is in motion?

*Pradeep Chowdhary
Udaipur (Rajasthan)*

Newton's first law of motion states that a body continues to be at rest or in motion unless it is acted upon by an external force. This basic property of a body is known as "inertia". Inertia resists the motion of a body if it is at rest.

If it is a motion, it offers resistance to the force that tries to stop it. When a cycle, or for that matter, any vehicle is at rest, a considerable force is required to overcome inertia and set it into motion. Once it is in motion, it continues to move without the need of the extra force. A cyclist has therefore to pedal harder in the beginning than when the cycle is in motion.

Dilip M. Salwi

In a cinema hall, why do we not enjoy watching a movie from very close to the screen ?

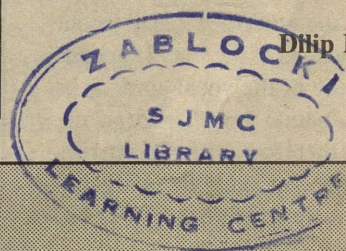
*Shalabh Saxena,
Allahabad (U.P.)*

The moving pictures in a cinema hall are projected by a system of lenses on to the screen. One can enjoy a movie most if the angle the screen subtends at one's eye is equal to or nearly equal to that it subtends at the projecting lenses. When



one watches the movie sitting very close to the screen, this angle at the eye becomes very large. The eye, even the head, has to be turned frequently to follow the images projected on the screen, which can be a strainful experience. That is why it is uncomfortable to watch a movie from close range.

Dilip M. Salwi



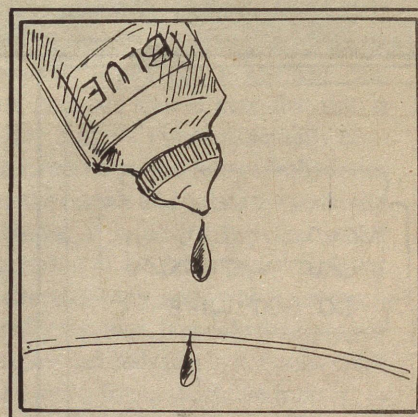
Why do we use blue while washing white clothes ?

*Subrata Mukherjee
(Kanchrapara (W.B.))*

Regular washing of white clothes with soap leaves a yellowish tinge on them. Blue is used to make these yellowed clothes appear whiter. Blue, or indigo as it is better known, is nothing but a dye which sticks to the fabric. It absorbs the yellow part of sunlight thus masking any yellowishness of the cloth and makes it look whiter.

Now a days, chemicals called optical whiteners are added to washing pow-

ders during their manufacture, thus avoiding the use of additional blue after wash. These optical whiteners contain a fluorescent material which emits a bluish white light when exposed to ultraviolet light. Since blue is a complementing colour of yellow, it masks the yellowishness of the fabric. These optical whiteners are absorbed from solutions but are not washed off during rinsing. As a result the fabric reflects a greater portion of the white light and appears brighter.



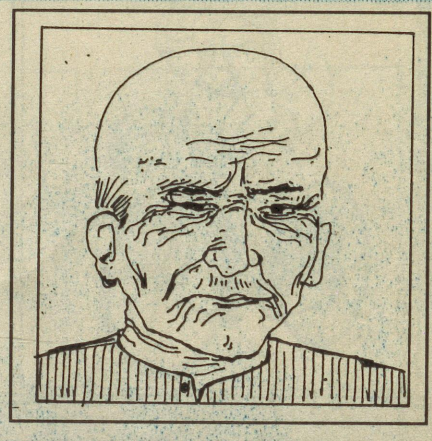
Madhu Sahni

Why does our skin become wrinkled in old age ?

Pawan Chhabra
Ballabgarh (Haryana)

The largest living organ of the body - the skin - is a highly elastic structure. As one gets older this elasticity of the skin is lost and hence it gets wrinkled. The lower portion of the skin has a lot of collagen fibres in it. These protein fibres are highly interlinked giving it the required elasticity. In old age the

cross linkages between these collagen fibres is lost leading to a shrivelled appearance. It is said that these linkages breakdown as a result of reactions with free radicals. Excessive exposure to ultra violet rays increases the wrinkles on the body; it is for this reason that the aged hill folk especially peasants have a highly wrinkled appearance.



Pallava Bagla

Why are the voices of a man and woman so different ?

Ashish Sethi
Dehradun (U.P.)

The voice actually is a modified sound produced from the vibrations of two muscular strings called vocal cords located in the voice box, deep in our throats. The tone of the sound depends on the nature of the vocal cord — its flexibility, actual length and so on. The voice, therefore, differs from person to person, and very distinctly between the male and female. This is so



because the vocal cords of males are slightly thicker and less flexible than those of females and so produce deeper notes. On the other hand, female vocal cords are thinner and highly flexible. That is why the female singers can sing with a very high pitch.

The vocal cords also change with age. In young boys, for instance, they are thinner and shorter and so their voice is pleasantly high pitched. But once they attain puberty the vocal cords grow thicker and become less flexible turning their voice hoarser.

Kollegala Sharma

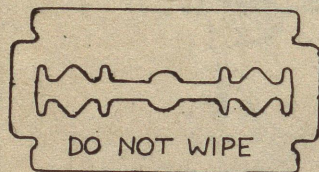
Why do safety razor blades carry the instruction "should not be wiped"?

Arvind Kumar Choudhary
Darbhanga (Bihar)

Modern safety razor blades are made of soft stainless steel unlike the hard carbon steel blades manufactured earlier. The cutting edges of these safety razor blades are therefore very delicate. To protect them against damage they

are coated with a wear-resistant plastic called "teflon". This coating also considerably reduces friction between hair and the blade edges making shaving comfortable. If the blade is wiped with a towel, it may damage the coating reducing the life of the blade. That is why it should be dried by shaking off the water.

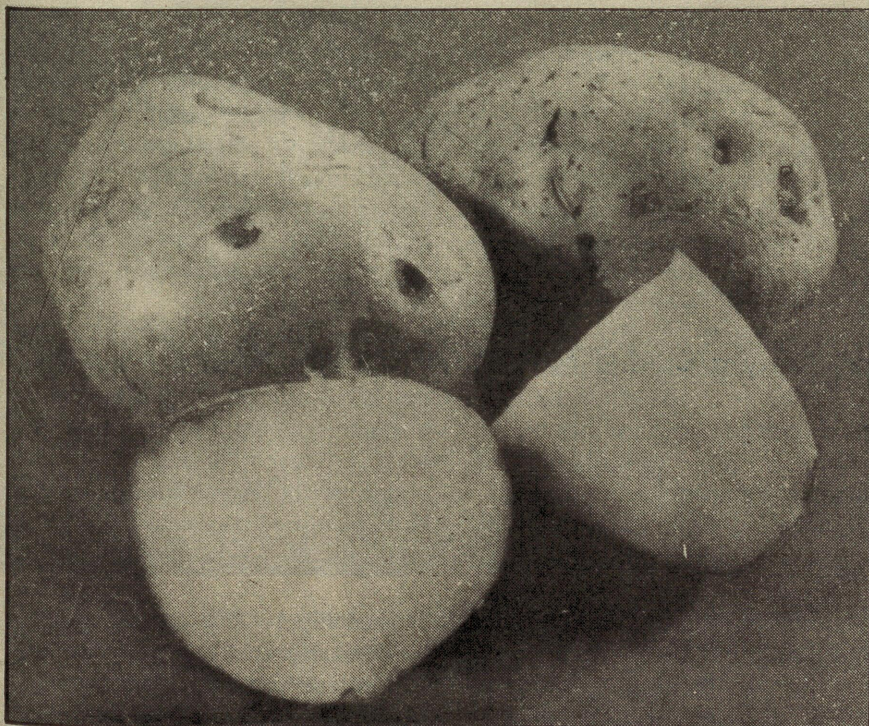
Dilip M. Salwi



Potatoes

Popular potato is not just a tuber, it is a packet of nutrition, reveals

VIRENDER SARDANA



POTATO (*Solanum tuberosum*) is one of the most important food and vegetable crop in India. It produces more food per unit area than the cereals and also gives returns in a much shorter period. Further, it can be stored as such without refrigeration for quite a long period. It is because of these inherent qualities that it has become one of the major food crops in the world, next only to rice, wheat and maize. The potato, a native of the high altitude of the Andes mountains of South America, has served as an important cultivated food since early civilization.

It is generally believed that eating potatoes makes a person fat. Figure-conscious ladies and gentlemen who shun potatoes should note that this is merely a myth. Potatoes actually contain more water and less carbohydrates than the cereals and pulses we generally consume. It is also a fact that major proportion of the fat in potato contains unsaturated fatty acids which are nutritionally superior. It is only the frying of potatoes that adds fats to it. Potato chips and French fries, which are a craze, in fact contain large quantities of oil or fat (upto 40 per cent) and as such provide much more energy than boiled potato. Also, for better retention of nutrients

Designer Potatoes

S.C. VERMA

POTATOES have sustained the people's of the south and central American highlands from times immemorial, but have spread far and wide only during the last four hundred and fifty years or so. However, potato has also contributed to the greatest peace time tragedy. During the Irish famine of 1845-46, over one and a half a million people died, and another one and a quarter million people had to migrate. All because the potato crop, on which the Irish people depended heavily, was affected by a deadly mold (fungus) causing late blight. The disease caused by the mold *Phytophthora infestans* is still prevalent and causes considerable losses in many regions of the world, including India. But, fortunately some wild relatives of potato which have been grown since about 1000 B.C. possess genes or traits, which protect them from the onslaught of the mold. But most of these species produce potatoes which are too small, odd shaped and of many colours and hues. These genes, for example, from a species *Solanum demissum* have been incorporated by plant breeders into the cultivated potato and many present day varieties are thus protected against late blight. It is another matter that the fungus is smarter than the humans and produces more complex races forcing the scientists to start all over again. While there are many other wild species which can be used to overcome such problems, yet the process of incorporating such genes is time consuming and can take anywhere upto 15-20 years, if the time honoured procedures employed by the plant breeders are followed.

Moreover, many of the desirable species don't mate with others necessitating adoption of other approaches. One such approach is protoplast fusion.

Protoplasts are cells whose walls have been removed. Protoplasts from two different species are allowed to fuse either naturally or under an electrical field (the later procedure is known as electrofusion). The fused protoplasts when provided with nutrition, divide and multiply to form a clump of cells, called callus. Plants can be regenerated from the callus by providing appropriate growth factors. The procedure is being used to impart tolerance to a pest — the root knot nematode — which occurs in soils and which disfigures the potato (and affects many other vegetables) reducing its market acceptability.

Wild species of potato are also being used to protect plants from viruses and fungi which cause diseases in potato. *Solanum brevidens* is one such species which has been used to produce potato plants, by protoplast fusion, which are resistant to potato leaf roll virus (PLRV). Scientists at the Rothamsted Experimental Station in the United Kingdom are using these plants to transfer PLRV resistance to cultivated varieties of potato. Another wild species *Solanum berthaultii* has been used by plant breeders at the Plant Breeding Institute at Cambridge, U.K. to produce new types of potatoes which can be stored at higher temperatures for considerable periods, without the use of chemicals for suppressing sprouting, and without an increase in the sugar content of stored potatoes. Potatoes stored outside the

cold stores start to sprout in a few weeks after harvest, leading to weight losses. These losses can be reduced by storing in a cold store. But in cold stores, the starch of the potatoes is broken down to sugars — glucose, fructose and sucrose. These sugars, specially glucose and fructose, if present in quantities higher than one part is one thousand parts, cause the development of dark pigmentation in chips and French fries prepared from such potatoes. To overcome the twin problems, processors all over the world store potatoes at 10° C and use chemicals to suppress sprouting. However, use of chemicals is likely to be done away by the European Economic Community in the near future. Crosses between *Solanum berthaultii* and some English potato varieties have led to identification of some lines which do not sprout for 160 days at 10°C and contained less than 0.1% reducing sugars (glucose and fructose) after 185 days at 10°C.

Genetic engineering is another approach to overcome some of these problems. Not only the useful genes from wild species of potato are being transferred into cultivated potato but help is being sought from as diverse organisms as chicken eggs and giant silk moth, or the greater wax moth, which feeds on honey-comb.

Peter Thomas, a virologist at the United States Department of Agriculture is collaborating with Monsanto & Co, in transferring genes for resistance to viruses "X and Y" to the most popular potato variety "Russet Burbank". They have identified a genetically altered line resistant in field trials to both the

and digestion, boiled potatoes are better than the fried ones.

Potato is a good package of all the major nutrients like proteins, vitamins,

calcium, potassium, phosphorus, iron. Three-fourths of every potato is water and the rest the nutritive substance. Energy giving starch content in potato

is generally 10-25% depending upon the cultivar, protein is 2 percent and ash is about one percent.

The quality of potato is assessed by

viruses. The line contains genes for the protein coat of the viruses (many viruses are made up of two parts, the nucleic acids and the protein cover or coat). The useful gene was 'introduced' into the potato plant with the help of a bacteria *Agrobacterium tumefaciens*, which normally causes tumors in plants. The bacterium contains a plasmid, a very small piece of DNA strand which can enter into the plant's DNA. Because

of this quality the *A. tumefaciens* plasmid is a perfect carrier of the desirable genes. And since it has been genetically altered it loses the ability to cause tumors.

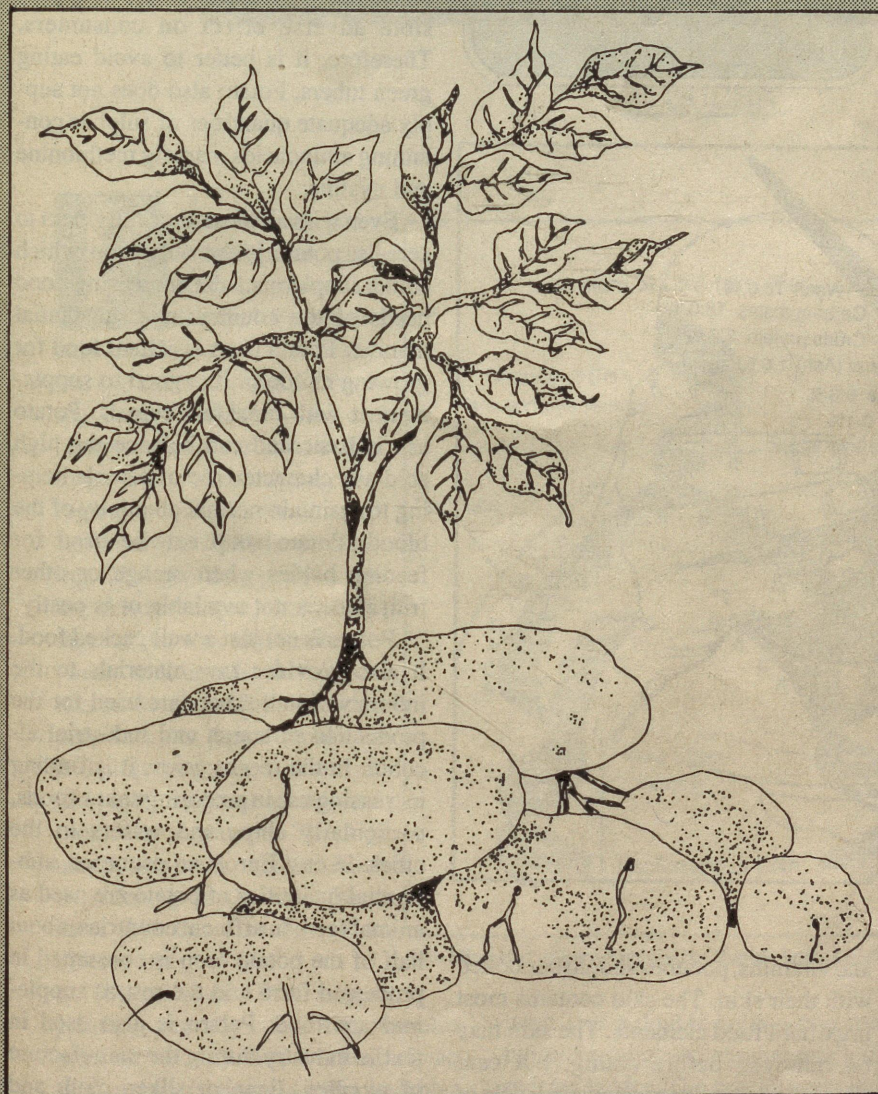
Another bacteria, *Agrobacterium rhizogenes* is being used in Italy to transfer a gene from the giant silk moth, *Hylophora cecropia*, to impart resistance to two diseases caused by bacteria. Bacteria of the *Erwinia* species

cause soft rot of potato and also a more damaging disease blackleg (which fortunately has so far not been reported from India), and *Pseudomonas* cause brown rot of potatoes (prevalent in large areas of the country). Some bactericidal proteins occur in the larvae of the giant silk moth, and it is hoped that these proteins when incorporated into potato plants, will confer resistance to the *Erwinias* and *Pseudomonas*.

Another moth, the greater wax moth, contains a protein which is rich in tyrosine (an amino acid occurring in many fruits and vegetables). Tyrosine is consumed by an enzyme in potatoes to cause blackspots below the skin of the damaged or bruised potato. The transfer of the protein gene from the greater wax moth, will according to the scientists, help in overcoming the problem which causes immense losses in the potato processing industry.

Resistance to bacteria causing soft rot and another causing ring rot of potatoes is being sought to be imparted from chicken eggs. A gene in the eggs protects the embryo till its own immune system is developed. This gene may defend the potato from the bacteria causing the two rots. World over scientists are busy identifying genes which can impart resistance from herbicides which kill unwanted plants in a field without affecting potatoes or to increase the content of sulphur containing amino acids to improve the quality of potato proteins, which is already better than those of cereals. In fact proteins, which is already better than those of cereals. In fact it is hoped that by the beginning of the next century, it would be possible to get potatoes 'made to order'.

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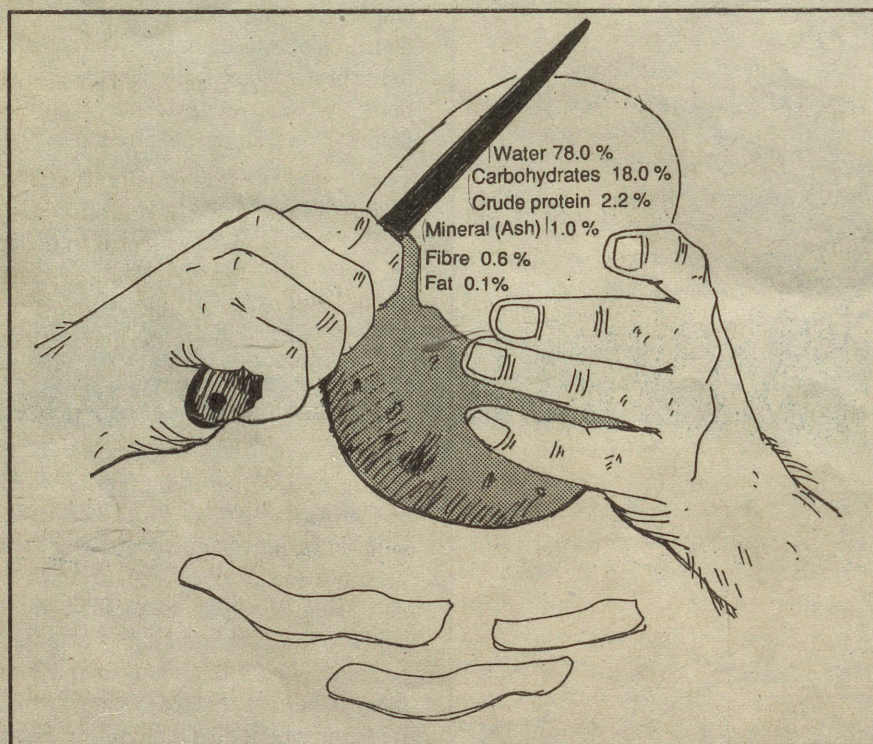
the water and starch content. Among the 20 aminoacids in the proteins of human body, only ten are synthesized in the body. Those aminoacids which

are not synthesized by the human body have to be taken as food and hence are known as essential amino acids. Potatoes can to a great extent overcome the

deficiency of lysin—an essential amino acid in humans, the deficiency generally occurs in Indians due to their predominately cereal-based vegetarian diet.

Because of better balanced amino acid content, potato protein is regarded superior to cereal protein. Almost half of the nitrogen containing compounds in potato are proteins. While the potato protein itself is nutritious, other nitrogenous compounds such as free amino acids and amides act as supplements. Potatoes also contain a rich variety of mineral salts. About one percent by weight of every potato consists of mineral matter. It is rich in potassium in addition to considerable amounts of calcium, iron and magnesium. It is a

**Next to cereals,
potato is the only crop
which
could supplement
the increasing food
needs**



Major constituents of potato tuber

good source of phosphorus as only about 20 percent of phosphorus is in the form of phytin (phytin is unavailable to human body).

Potato is a good source of vitamin C but its content varies considerably. Vitamin C content is highest in freshly harvested tubers but decreases during storage. As with other vitamins, vitamin C content decreases during cooking. For better preservation of minerals

and vitamins, potatoes should be cooked with their skin. The skin contains most important food elements. The skin may be removed before eating, but care should be taken not to allow a particle of potato to adhere to it as the valuable salts, lie just beneath the skin.

Potatoes also have a weakness. For instance, unsaturated fatty acids which are nutritionally superior are very less in potatoes. Moreover the fibre in pota-

toes is present only in the skin and unfortunately it is peeled off before consuming.

Potato tubers also contain some nitrogenous compounds—glycoalkaloids—which could be harmful if taken in large quantities. Under certain conditions such as exposure of tubers to light and low temperature, the quantity of glycoalkaloids increases in the tubers. If it becomes more than 20 mg/100g, the tubers could taste bitter, with possible adverse effect on consumers. Therefore, it is better to avoid eating green tubers. Potato also does not supply adequate quantities of sulphur containing aminoacids, namely methionine and cystine.

Even with all these shortfalls, next to cereals, potato is the only crop which could supplement the increasing food needs of the country in a substantial manner. Potato is an excellent food for growing children. It is good to supplement it with breakfast cereals. Potato ash is basic and can balance the high acid ash characteristic of cereals helping to maintain normal alkalinity of the blood. Potato soup can be used for feeding babies when orange or other fruit juice is not available or is costly.

Potato is not just a well packed food. It also provides raw materials to the industry. Small tubers are used for the production of starch and industrial alcohol. In the recent years, it is finding increasing use in preparing snack foods, particularly chips and wafers in the cities. In east European countries, substantial quantities of potato are used as animal feed. In affluent countries, about half of the potato crop is consumed in processed form and the rest as supplementary food. Potato is also used in textile industry during the manufacture of woollen, linen or silken cloth and also for manufacturing potato flour, glucose, syrup, candy desiccated potato for food, industrial alcohol, mucilage dyes among otherthings.

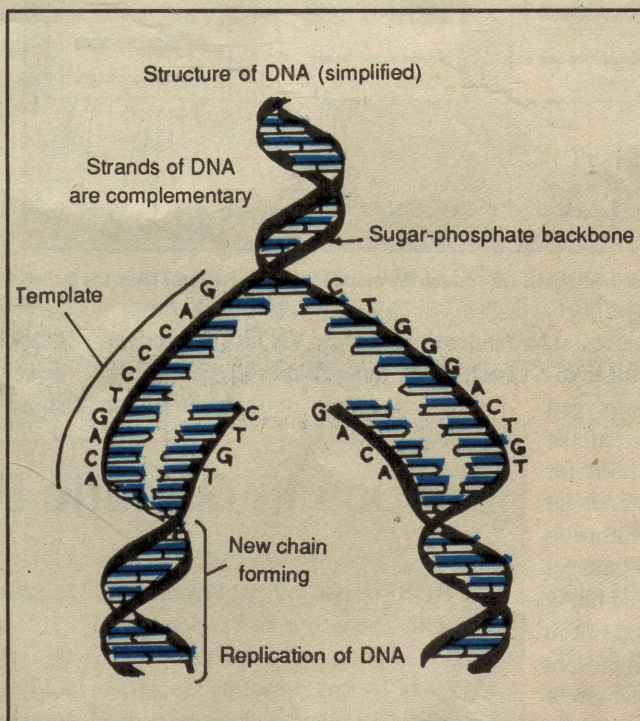
Shri Sardana is a researcher at the Haryana Agricultural University, Hisar-125 005

MOLECULAR SIGNATURES

T. SUDHA

From solving paternity disputes, bringing criminals to book, locating disease-causing genes in a haystack of chromosomes, to reaching back a million years and reconstructing the natural history—a new revolutionary biological technique can do it all. Referred to as DNA fingerprinting, DNA profiling or DNA typing, this technique takes advantage of the tiny difference between individuals at the molecular level. Indeed, scientists peep into our genetic make-up and pinpoint portions which are unique to each one of us—our molecular signatures. This signature can not only establish our identity at the most basic level, but can also be put to diverse uses.

The story of DNA fingerprinting naturally starts from the blueprint of heredity. The nucleus of each human cell contains a complete blueprint for a man or woman. This information is distributed on 46 chromosomes made primarily of long chains of DNA (deoxyribonucleic acid). DNA is the master chemical that controls the development and functioning of organ-



The blueprint of heredity is in the double helical molecule, DNA

isms. It is a double helix—two strands twisted around one another much like a twisted ladder. The crucial components of each DNA strand are four molecules of nitrogenous bases—adenine (A), thymine (T), cytosine (C) and guanine (G) strung along a sugar phosphate backbone. The rungs of the ladder are formed by the pairing of A of one strand with

the T of the other. Similarly of C with G on the other strand.

The genetic blueprint is actually a code of instructions. The words in the code—sheet are all three lettered, spelt by the various combinations of the four nucleotide bases. Each word designates an amino acid and the entire DNA string is a code of instructions for assembling amino acids into large proteins. A discrete segment on the DNA—a genetic sentence—instructs just the production of a single protein. And because of the specific affinity between adenine and thymine, guanine and cytosine the instructions on one strand of the double helix is reflected by the other strand.

Between one individual to the next, 90 per cent of the DNA is identical. But there is 10 per cent of the DNA that is different—a unique sequence of bases present in each one of us. The trick in DNA fingerprinting is to examine those parts of the DNA molecule where there tend to be differences rather than the far more numerous places where they are similar. DNA finger-

printing thus identifies the slice of heredity unique to an individual, as unique as a fingerprint or signature and as distinct as clichés used by an author.

THE credit of discovering this uniqueness from three billion base pairs of human genome goes to Alec

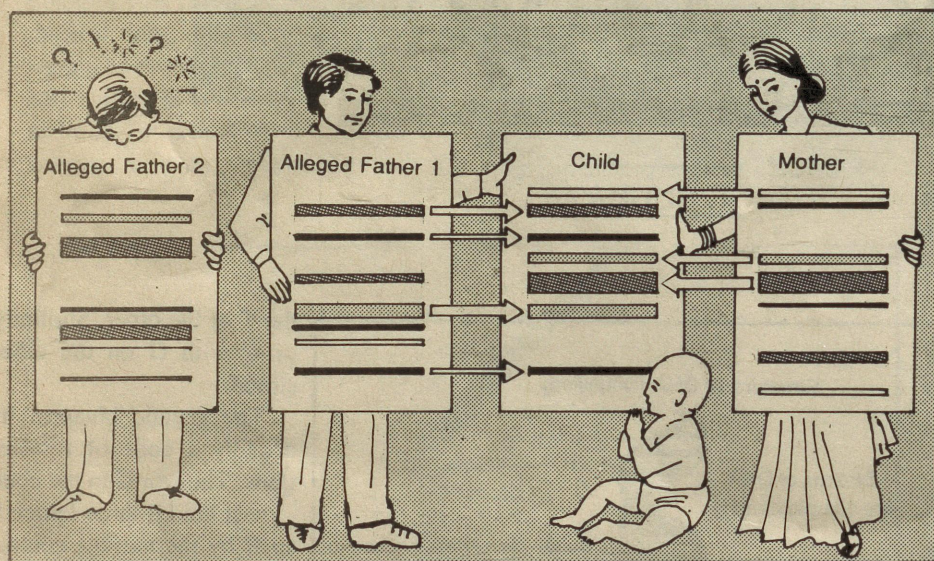
Jeffrey. One person might have 13 repeated units at that place on the DNA, whereas another might have 29. Only identical twins end up with the same number. Because the number of repeats tends to vary among individuals, the areas are known as 'variable number

of repeats' or VNTRs.

But, out of the billions of base pairs how does one locate the VNTRs? Here is where the sophisticated technology has made the entire procedure simple. The key tools for this purpose are special enzymes called restriction endonucleases. These are molecular scissors and can cut DNA at specified points into pieces of various lengths. The pieces will contain the VNTRs as well.

TO get an individual's molecular signature, all the pieces of DNA cut by the restriction endonuclease are sorted out according to their size. This is done by a technique called electrophoresis. Here the molecules are filtered on a porous gel. First, the pieces are placed at one end of an agarose gel slab. The pieces of DNA have a negative charge and move towards a positively charged electrode through the gel, when an electric current is passed through it. The shorter, lighter fragments travel more

quickly through the gel, while the longer heavier fragments lag behind. After some time, the caravan of the moving



Those bands in the child's DNA fingerprint that do not match the mother's must have come from the father

Jeffreys of the University of Leicester, U.K. While studying the gene for myoglobin—the protein that stores oxygen in muscles—he found that some parts of the gene did not carry instructions for the manufacture of myoglobin. Each bit of such DNA not carrying any information for the protein was an unusual sequence of some bases repeated many times. Such a sequence is found not in a particular part of DNA, but is present at many places throughout the length of the DNA. For instance, the repeat sequence found in the myoglobin gene is also present elsewhere. If the chain of the base pairs in a DNA molecule were a gramophone record, these areas would be the points where the needle became temporarily stuck in a groove and repeated the same notes a number of times before playing the rest of the tune.

While everyone has these repeated base sequences in their DNA, the number of repeats is unique to every indi-

vidual. Each of us inherits these repeats from our parents, some of them from our

Probes In Genetic Fingerprinting

PROBES are synthetic bits of DNA with a sequence of bases complementary to the target sequence. Those used for DNA fingerprinting are of two types: Multi-locus probes and single locus probes.

Multilocus probes are short lengths of DNA, which bind to DNA at several places and thus produce many bands, for comparison. This is particularly useful in paternity testing. When many bands are analysed, paternity is established with virtual certainty because in unrelated people, only one in four bands match another person's DNA finger-

print. Single locus probes are single long lengths of DNA which bind to the DNA only at one point. In any individual only two bands will be produced using this probe — one from father and one from mother. Forensic investigators usually use three or four different single locus probes on a single sample to produce DNA prints consisting of six to eight bands. This leaves little room for doubt in identifying the criminal. Even partially decomposed DNA shows a clear profile with single locus probes.

T.S.

pieces of DNA would have broken into groups of lighter pieces leading the procession and the heavier, larger molecules following them. When the current is switched off all these pieces stop in their tracks and each group sticks to its place in the procession. Thus we get bands of DNA pieces along the gel. The two strands in each bit are then separated by a chemical treatment. The separated bits of DNA in the gel are copied on to a nylon paper by blotting.

The next step is to see which of these bands contain the 'repeats'. But seeing these invisible fragments is not easily done. It needs the aid of a 'probe', a short piece of DNA which marks out the required stretch of DNA from a collection of them. DNA probes are made in the laboratory and contain repeated sequence of bases complimentary to those on VNTRs. The probes are like a book - mark, marking a particular page. But they are book marks with a difference. They have some words written on them and mark only those pages which have similar words.

Large numbers of these probes are prepared by a process called cloning. The repeat sequences are tagged on to plasmids of bacteria. As bacteria multiply, the repeat sequences multiply in number, thus getting many copies of the probes. It is then easy to attach a radioactive label to the probes.

In most genetic fingerprints, two types of probes are used: multi-locus probes or single locus probes (see box on page 40). These probes bind to the repeat sequences on the nylon membrane. Excess unattached probe is washed away. At this stage the signature is on the DNA are marked out yet are not visible to the eye. To make the pattern of bound fragments visible, an X-ray film is exposed to the nylon sheet. The places where the radioactive DNA probe has bound to the DNA fragment, is reflected on the X-ray as distinct, dark bands. These bands are the DNA profiles or DNA fingerprints. The final DNA fingerprint on an X-ray film con-

Great Expectations ?

DESPITE its popularity and success, like every other newly introduced technology, DNA fingerprinting too, is having its teething problems. There are several disadvantages in the methodology and interpretation of results that will need to be perfected. Great care need to be taken to carry out genetic fingerprinting tests. Forensic samples such as blood stains on clothing or fabrics are likely to be contaminated with other material. Fungi and bacteria are almost always present in every one of such samples. In fact, no sample must be even touched with hand at any stage during the processing. Dyes, such as those from blue denim jeans can combine with restriction enzymes and cause them to cut in the wrong places.

DNA is a very sensitive molecule and decays rapidly, especially in warm or damp conditions. If the DNA has decayed, some of the sites

attached by restriction enzymes may be lost, thus resulting in too few or too many fragments.

If contaminated fragments of DNA are sorted in a gel, the pattern produced can be entirely different. The contaminant will change the net charge on the fragments and hence their movement through the gel. Proteins from the environment for example, when attached to DNA fragments can considerably affect their mobility. This will result in a phenomenon known as bandshift. Fingerprint analyses is done according to the position of the bands and any shift can have disastrous consequences.

Despite the problems, DNA fingerprinting is no doubt here to stay. Many more applications for the technique will be developed. Indeed the day is not far when a person's genetic material will be turned into his ultimate identity card.

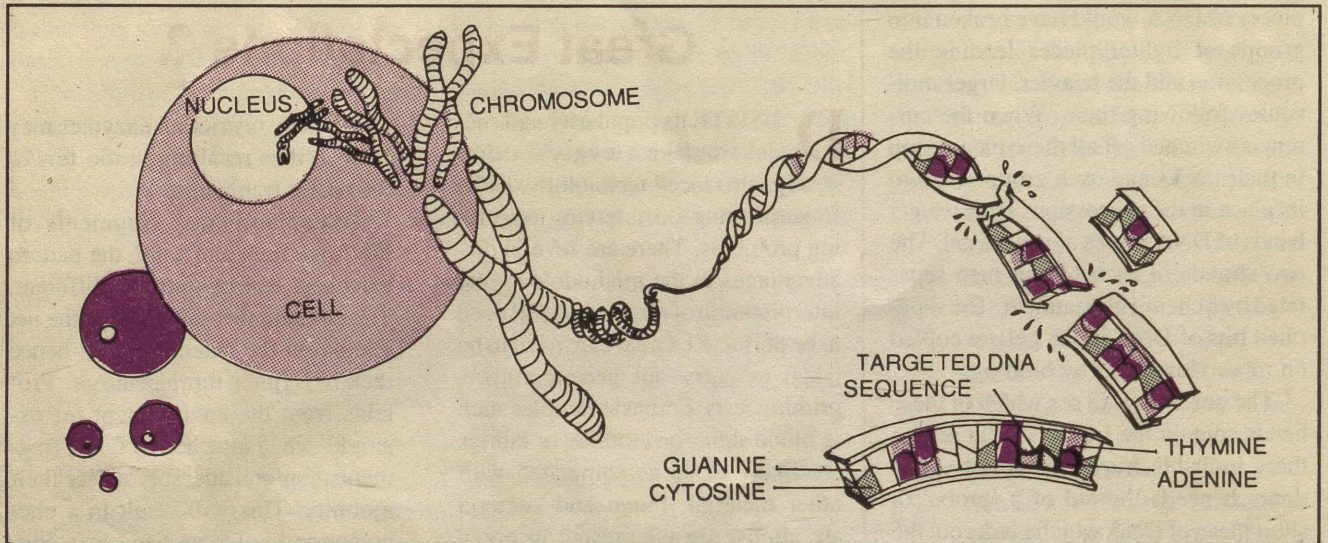
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tains light and dark bands. This profile is described as a series of numbers, each referring to the length of the DNA fragment, calculated by measuring how far the fragment has travelled through the gel compared with molecules or fragments of known length.

As the number of repeated segments varies among individuals, so too does the overall length of these fragments. Thus just as the number of VNTRs varies, so too does their overall length. Thus, when an analyst compares two samples containing VNTRs, if the VNTRs of the two samples occupy different positions on the gel, they are VNTRs of different lengths and hence from different persons. On the other hand, when VNTRs occupy the same position on the gel, they are of same lengths and are from the same person.

The technique has shown a lot of promise and has been used in diverse areas, one of them being settling paternity disputes. A child inherits half its DNA from its mother and the other half from its father, DNA fingerprints help solve disputes about who the father is. Those bands in a child's DNA fingerprint that do not match its mother's must come from the father.

Zoologists fingerprint species of animals facing the danger of extinction to learn their breeding patterns. Such a study is underway on the whales in the North Atlantic Whales. Once prized for their blubber and baleen they were hunted almost to extinction by mid 1800s. Besides, low reproduction probably because of inbreeding has reduced the population. Alarmed by the lowering numbers, researchers are us-



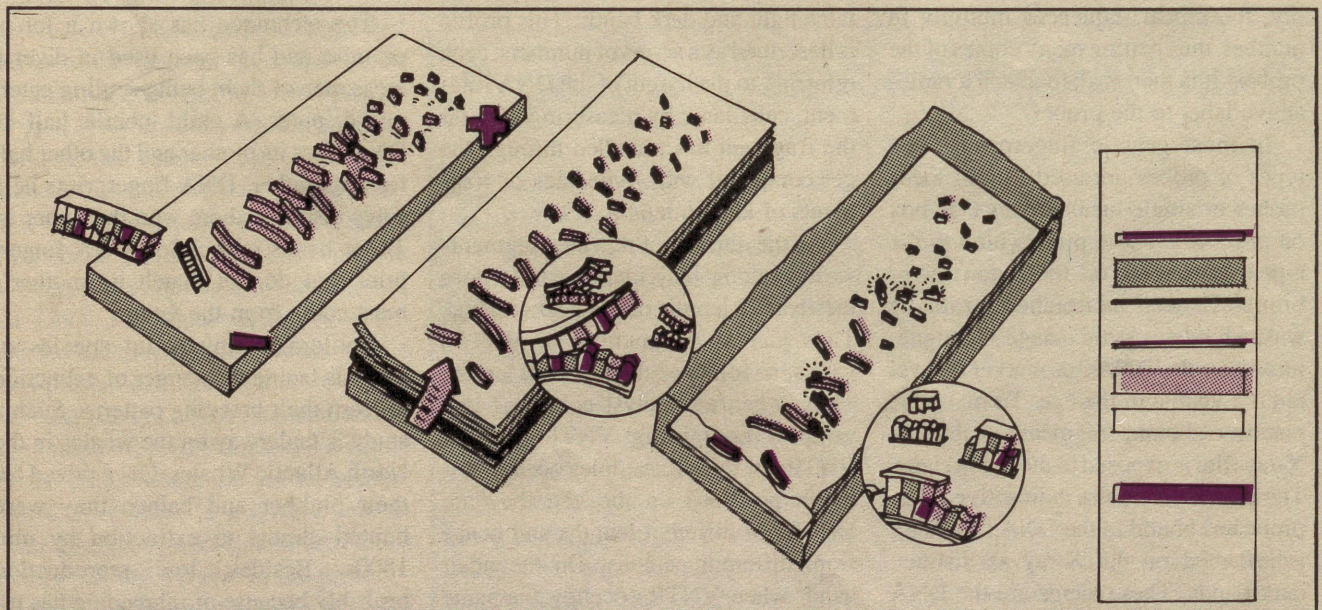
DNA fingerprinting essentially involves extracting DNA from the cells, cutting it into pieces with restriction enzymes and separating the pieces by electrophoresis...

ing DNA fingerprinting, together with photographic identification to determine how many of the males are fathering calves. They have extracted DNA from whale skin and obtained fingerprints that will reveal paternity. For animals in captivity as in zoos, fingerprinting can identify unrelated pairs that can be bred to increase genetic diversity.

Doctors restoring health to patients

suffering from the fatal blood cancer—leukemia—also seek the aid of DNA fingerprinting. This technique helps them to test the success of bone-marrow grafts. Bone marrow is the tissue in bones from which all blood cells are born. Before grafting the marrow, all the blood-cells in the patient body are killed. Fresh marrow taken from a close relative are injected into his blood. The

injected marrow produces fresh and healthy blood cells to give a new lease of life to the patient. The success of the treatment will depend on the complete absence of patient's own blood cells from the scene and the presence of a large number of cells born from grafted bone marrow. Distinguishing these in the patient is a bit difficult because both the cancerous cells of the patient



...The fragments containing the molecular signatures are marked with radioactive probes and photographed. The final picture emerges as a pattern of dark and light bands on the X-ray film which is unique to each person (after National Geographic)

BIOTECHNOLOGY

and the graft-produced cells are more or less alike in appearance. DNA fingerprinting technique helps to detect how many are the survivors from the patient's cancerous blood cells. This technique can thus give a pulse of the bone-marrow graft's success.

DNA fingerprinting can also help solve some intriguing questions regarding evolution. In the course of evolution, the DNA undergoes changes, yet distinct similarities exist between the present day organism and its ancestor. This helps researchers to track down forefathers. For example, this technique can be used to see, who among the chimpanzees and gorillas is a closer relative of humans or, who are more ancient—the negroid races, whites or browns. In other words, who were the Adams, and such other evolutionary studies are now possible with DNA

fingerprinting. Researchers have extracted DNA from mummified human remains in Egypt. DNA sequences from such ancient specimens will be compared with those of present day populations in Egypt and neighbouring countries to see how exactly they are related. Similarly by comparing the DNA fingerprints of quagga, a zebra-like animal that became extinct in 1883 (the DNA was isolated from a museum specimen) with that of the present day zebra, they have been able to show that zebra and quagga had a common ancestor.

THE most prominent role played by DNA fingerprinting has been in crime detection. Rapists, murderers, burglars often escape punishment due to lack of convincing and conclusive evidence. Thanks to DNA fingerprinting, tiny specks of blood or a few hair

roots left at the scene of the crime are sufficient to identify the culprit.

Fully decomposed dead bodies, which are otherwise not identifiable can be identified by comparison of the DNA fingerprint from the body with those of living relatives such as parents, brothers and sisters. This can lead to a positive identification. The most noted case of its use has been in identifying the suspects in the assassination of the former Prime Minister, Rajiv Gandhi. This technique was used in establishing the identity of the human bomb Dhanu. The mastermind in the conspiracy, Sivarasan's relatives were traced from blood samples supplied by Sri Lankan authorities, after his death, using this technique.

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No, No! Not at all. Don't ask anything on Global warming. Boss is terribly upset at the moment as there is a power failure (Cartoon by Pradeep Srivastav)

DIGGING UP EVIDENCE

ANIL AGRAWAL

"Good morning, doctor. Why did you ask me to come to this graveyard? What are we to do here?"

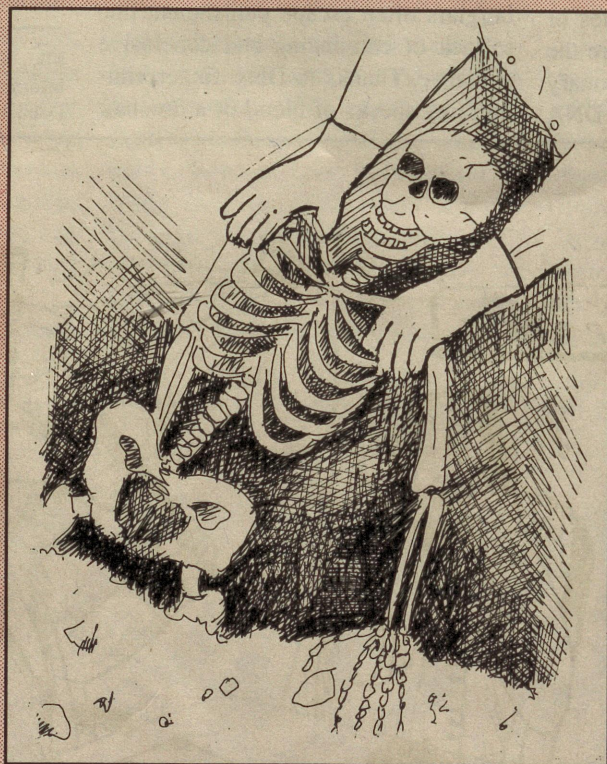
"Good morning, Tarun. We are to recover a dead which is buried somewhere here since about three months...."

"What ! That's very ghastly !"

"Tarun, you must have read in the newspapers about three months back, that Mr. Ram Lal, a businessman, was missing from his house.."

"Yes, I did read about him. He had left his house to meet some of his business associates, and never returned. Newspapers splashed his story on the front page because he was such a prominent person of this city."

"That's right. Well, today morning the police received a call from an anonymous person saying that Ramlal's dead body was buried somewhere in this area. On the day of his disappearance, he left his house with a big amount of cash in a handbag. We have confirmed this fact from his wife. I believe Ram Lal was getting involved in some shady deals in which he had to deal with some criminals. I suspect that once he reached the stipulated place, the



criminals did away with him, took his cash and buried his body somewhere here. Later a dispute must have arisen among the criminals themselves about the sharing of the cash and one of the disgruntled criminals has informed the police about the body."

"As I understand doctor, this body must be lying here for almost three months. It must have decomposed a lot. What clues can it offer?"

"Sure, if we look hard enough, we can find enough clues. First of all, we will have to exhume the body. Unearthing a buried body is known as exhumation. We resort to exhumation in several different setups. One is when the police receive information from unknown callers or informants that a dead body is lying buried somewhere. The present case is an example of this. Sometimes a criminal who has been caught confesses to the police under sustained interrogation. Many a time, during digging, for building or other purposes, a body may be found."

"Oh, I see."

"These are the instances when the body was buried to hide the crime. Many a time we have exhumed bodies which had been properly buried with religious rites by the relatives."

"Why ? It is really surprising that first a body was buried without a postmortem examination and later

CRIME BUSTERS

exhumed to do a post mortem. If there was some suspicion regarding the cause of death, why isn't the post mortem examination done in the first place and then the body buried?"

"That's a good question. Sometimes at the time of death, it appears that the death was natural and nobody not even a doctor, suspects the cause of death. Later on, may be after 3 months, 6 months, a year or even 10 years, somebody may come across some strong piece of evidence that the person didn't die a natural death but was in fact murdered. In such cases the body will have to be exhumed to conduct a postmortem examination. I must tell you that for exhuming a body that was traditionally buried in a cemetery we must have written permission from a magistrate. Even the police cannot order an exhumation. Such a procedure has been adopted so that exhumations don't become common place. Only when there is an overwhelming evidence that a person was murdered, does a magistrate give permission to exhume the dead. Ex-

humation is only possible among those religions which bury their dead. Some people embalm the dead body and then bury them which makes autopsy more difficult. Finally, there are rare instances when at the time of death the post-mortem was indeed conducted and then the body buried, but later allegations arose that the post mortem examination was incomplete, careless or even biased. In such cases the body may have to be exhumed and a repeat post-mortem done by a different doctor. It may sound like playing havoc with the dead body,

but it is all done to do justice to that person albeit posthumously."

"Yes, I can understand that. You have only been told that the body is buried somewhere here. How are you going to find the exact place where it is buried in this vast area? Are you going to dig up the whole site?"

"That wouldn't be necessary perhaps. However I must tell you that when vast areas have to be searched for a

steel rod which is about 1.3 to 1.6 m long with a "tee" handle on one end and a sharp point at the other. The probe is inserted into the suspect area. If the ground is soft it is left in place, all probing is halted, and a vapour detector is brought into play..."

"Just a minute, doctor. What is a vapour detector?"

"Tarun, it is an instrument which detects the presence of gases formed during decomposition of the body. It can be used to locate a dead body prior to any excavation. It is quite useful when several suspected areas must be checked. We can also use it under concrete such as under roadways, patios and floors. We bore a small hole through the concrete and pass the metal tube beneath, through the hole. Without the vapour detector, we would have to do too much unnecessary demolition and destruction."

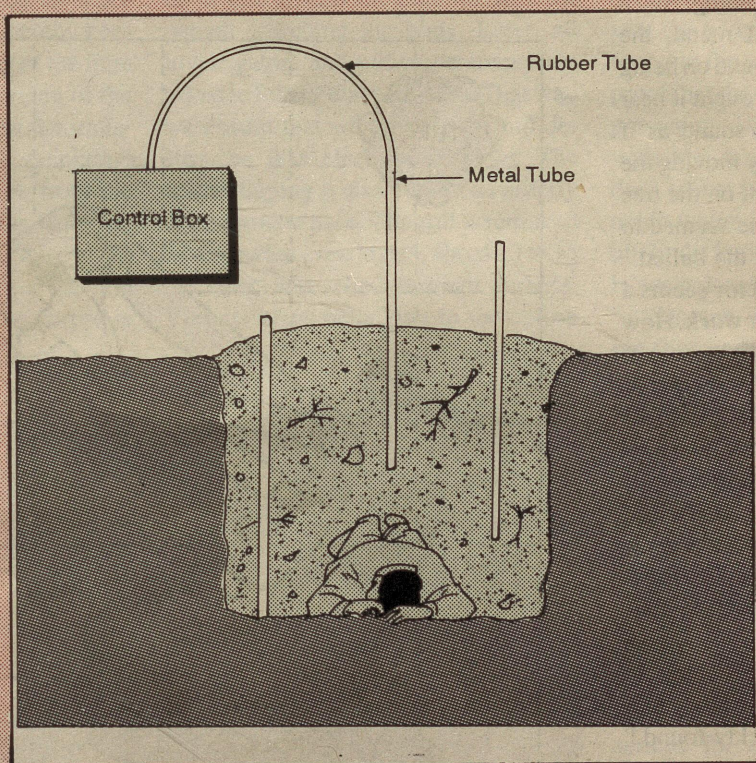
"Oh. What care do you have to take while using the vapour detector?"

"Tarun, it is very important that the metal tube used for collecting

the vapours is directly over the body. It should also be inserted to the right depth; otherwise, the vapours may be missed. Once we locate the body, we must thoroughly search the surrounding areas, preferably with a metal detector."

"Why?"

"Well, the murderer may have hidden the weapon such as a knife or dagger nearby and if found it will be a very strong piece of evidence against him. Sometime back, when we unearthed a dead body, I found a bullet



Using vapour detector, a buried body can be detected without digging up

buried body, the search may often be made even by an aircraft. Search by an aircraft can cover a wide area and locate, visually, a disturbance in the soil or vegetation. In addition, we can use thermal infrared photography which detects the heat emanating from a decomposing body. For smaller areas like this, search by foot would be a very practical method. It is generally combined with probing..."

"What is probing, doctor?"

"Tarun, probing is the most practical method of ground search. It is done with

CRIME BUSTERS

hole in its head. He had been shot through his head. This meant that the bullet had escaped his body and should have been somewhere around. A thorough search of the surrounding area failed to recover the bullet. It seemed unlikely that the murderer picked up the bullet and ran away with it. All our efforts seemed to be ending in vain. Then we used the metal detector—the type of instrument which security personnel have to search you with, when you enter an important building. Since the bullet is made up of metal, the instrument would emit a sound on being brought near it. When I brought it near a tree, it started emitting sound as if some metal was nearby. By moving the detector, I located the point on the tree trunk from which this noise seemed to come. And here we found the bullet!”

“Sure. The metal detector seems a valuable apparatus in your work. How does it detect a metal?”

“Tarun, metal detector is basically an instrument which emits and receives electromagnetic radiation. A transmitted signal generates electrical currents in surrounding conducting materials, such as metals, which in turn start emitting electromagnetic radiation. Electromagnetic radiation from these metals is received back by the apparatus and converted to a whistling sound. So when we move the detector close to a metal object it will be quickly found.”

“Can you also find out, how long the body was buried?”

“That’s a very important thing for us to determine. As soon as a person dies his body starts decomposing. As more time passes, the decomposition changes become more pronounced. (See SR June, 1991). So we can note the decomposition changes in a body and form a rough idea as to when the person was killed. However in buried bodies, we have to look for a few more things to decide. When a criminal digs a grave, he usually dumps the soil alongside the grave. As a result, the surface vegetation such as grass is usually compressed or

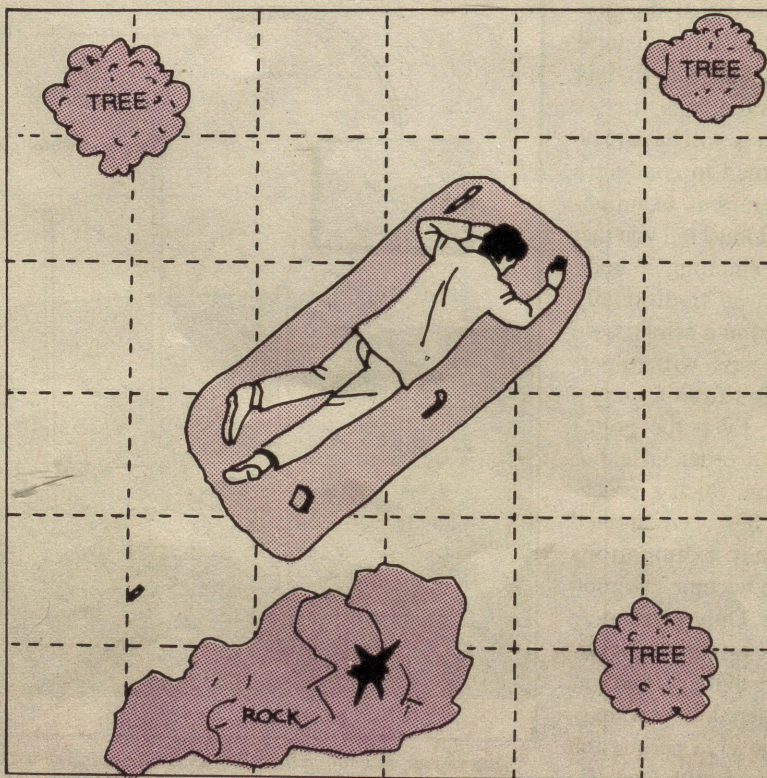
broken off. When the grave is refilled with that soil, some of this surface vegetation invariably also gets into the grave. This is where forensic botanist comes into the picture...”

“Oh, so there are forensic botanists too. It appears that almost any kind of scientist can help in the detection of crime in some way or the other.”

“You are right, Tarun. A forensic

the remains to have reached that stage. Sometimes, dead insects, insect larvae or maggots are found at the site. A forensic entomologist can examine these insects and give us the time of burial in the same way.”

“Oh, that’s quite interesting. I have read in some detective novels that often criminals bury the murdered person in quicklime. Apparently they do it so that the body decomposes



The ground has to be marked before any digging is done

botanist uses his knowledge of botany in the detection of crime. A forensic botanist would examine the dead plants to estimate as to the time when the vegetation was damaged. That would give us the time of burial which should be very close to the time of killing. Furthermore, if the body has been buried for some time, roots of trees or bushes may grow through the remains. The forensic botanist can also tell us the length of time necessary for the roots in

faster and the evidence is destroyed as soon as possible. Is it true that quicklime aids in the decomposition of the human body?”

“That’s an interesting question. Way back in 1847, a couple, Frederick and Maria Manning, murdered a person, Patrick O’Connor, for money and buried his body in a pit of quicklime beneath the kitchen of their house. When after eight days, his body was unearthed, it had decomposed so badly that it could

only be identified by a set of false teeth. The Mannings sure enough were executed for their crime in November 1847, but it is doubtful if they could have been prosecuted had the police been a little late or if O'Connor didn't have a set of false teeth. However, it is a myth to say that quicklime will always hasten the destruction of a corpse. A great deal depends on whether or not the body is clothed. Another important factor is the rapidity with which the lime is dissolved (slaked) absorbing moisture from the surrounding soil, thereby generating heat. Sudden slaking of the lime may result in superficial burning of the body. In several cases when the moisture in the soil is not enough, quicklime slakes by taking up moisture from the corpse and its organs. If this happens, the body is preserved rather than being decomposed. I must tell you that the presence of water within the corpse is

first instance. But if we have good photographs of the entire area, we can always refer back to those photographs later at leisure and, more often than not, these photographs reveal interesting clues. We also mark out the area to be searched with a grid. The idea is to search each section of the grid carefully with a probe or vapour detector as already explained to you. That way we are sure that we do not miss out any place. Another important thing that we do is to mark off the path used by the person searching the body. Later, all investigators and police personnel are asked to follow that path only. That way we ensure that we trample on and destroy as less clues as possible. The actual digging is also done at an orderly or systematic pace. The soil is removed in somewhat even layers, about 10 to 15 cm deep and sifted through screens. Various items belonging to the corpse

"Why do you do that?"

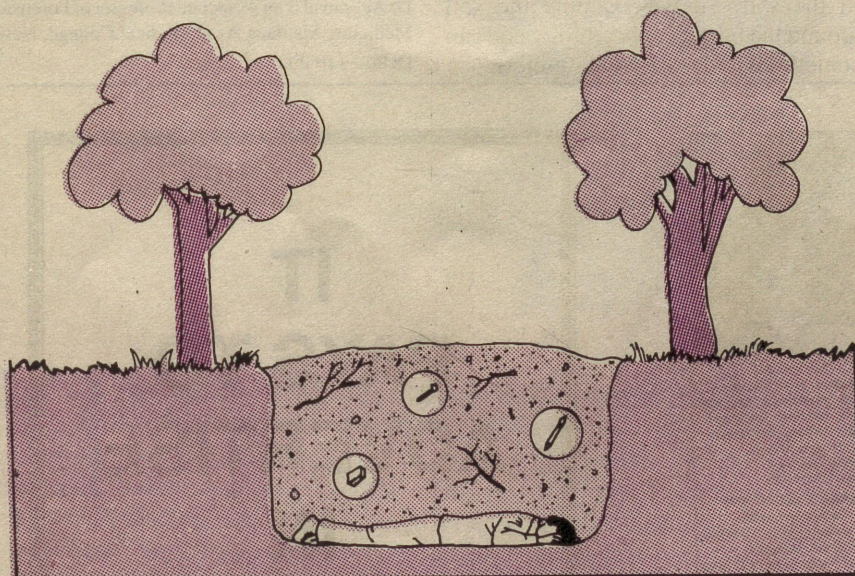
"Tarun, in deaths due to certain poisonings such as arsenic, we find quite logically and expectedly, high dose of arsenic in the body on chemical examination. If we don't take the sample of soil from around the body, the accused may later claim that the arsenic found in the body actually seeped into the body from the surroundings, after the burial. All soils do contain some amounts of arsenic. But if we can demonstrate that the concentration of arsenic found inside the body was quite high than that found in the soil, it would be a positive proof that the death did indeed occur by poisoning. Here I must tell you that whenever toxicologists talk of arsenic, they mean its poisonous salt arsenic oxide which is also known as *Sankhya* in Hindi. Pure arsenic in metallic form is not poisonous at all."

"Doctor, earlier you were telling me that bodies which are legally buried are also sometimes exhumed. When does exhumation become necessary?"

"As I told you if there was no suspicion regarding the cause of death and the post mortem was never conducted, but a suspicion arose later, the body has to be exhumed and the post-mortem examination conducted. Exhumation is done not only for suspicion of murder but also sometimes for civil purposes such as life insurance claims or civil actions for damages. Sometimes, in cases of disputed identity, exhumations may have to be done."

"Could you please explain?"

"Let us say that a person A is missing and sometime later a highly putrefied body is recovered. The relatives of A can't identify the body because of the high degree of decomposition but find that he is wearing the same shirt as that of A and thus conclude that it was indeed A. A post-mortem is conducted and it is found that he was run over by some vehicle. The relations assume that some speeding vehicle must have killed him which is quite common in our country. But lo and behold! One month



Every object near the body is to be identified as to its position below the ground

necessary for decomposition as otherwise the bacteria can't act on it."

"That's indeed quite interesting!"

"Tarun, whenever we rush to the place of exhumation the first thing we do is to photograph the entire area. Sometimes clues such as tyre tracks or foot prints are not very obvious in the

such as pen, cigarette, comb may be at different levels. By sifting the soil in layers, we can definitely say which object was lying in which layer. Thus we can draw up an elevation plan to pinpoint their actual locations. We also take adequate samples of soil from around the body."

after this incident, 'A' turns up in flesh and blood. A great event for A's relatives no doubt, but the investigating authority is immediately faced with the question—who was the man who was buried earlier? So it becomes necessary to exhume his body and the doctors try to establish the identity of that person. Several methods are available for the identification of a highly decomposed body. One is by the examination of teeth. So, exhumation as you can see is done for a variety of different purposes."

"While exhuming the bodies in such cases do you undertake the same precautions, as you do while exhuming bodies buried by criminals."

"No, that is not necessary. After taking the proper permission from a magistrate, we go to the cemetery where the body is buried. A police officer often accompanies us. To avoid on-lookers, exhumation is often done very early in the morning. The grave is identified. After that the procedure is fairly simple. We, however, do take care to collect samples of earth from around

the coffin for reasons already explained. If the grave is water logged, we take samples of water too, for the same reason. After the body—or whatever is left of it—is taken out, we conduct a full post-mortem examination. You must remember that if the body has been buried for quite a long time, we may find only the bones. In such cases we examine the bones very thoroughly. Quite a lot of information can be gathered from bones also. Bones may be fractured which indicates attack by a blunt force. Several metallic poisons, such as arsenic, collect inside the bones so a chemical analysis of the bones can tell us if the person was poisoned or not. We also X-ray the remains to locate the fractures. Sometimes in X-ray picture we can find bullets which is indeed a great find. Sometimes when the body is exhumed after a long period, the whole coffin may disintegrate, the body may skeletonize and if any bullet was indeed present inside the body, it gets mixed up in the soil. So we examine the soil around the bones very carefully and can sometimes indeed retrieve bullets."

"What are the other precautions you follow?"

"While exhuming the body, we must take care not to inflict any injury on the body. The bones may be quite fragile and can get fractured even by slight pressure. In one case which I remember, the doctor was somewhat careless in exhuming the body and somehow the casket collapsed. On autopsy it was found that an important neck bone—the hyoid—was fractured which clearly indicated that the person had been strangled. However, everyone knew that during the exhumation, the casket had collapsed. So the defence argued that the said fracture was caused by the inept handling of the body by the doctor, rather than by strangulation. And quite predictably the defence won."

"Thank you doctor for telling me so many interesting things about exhumation."

Dr Aggrawal is an Associate Professor of Forensic Medicine, Maulana Azad Medical College, New Delhi - 110 002

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WORLD COMMUNICATION YEAR

On November 19, 1981, the United Nations General Assembly adopted a Resolution and declared that 1983 would be observed "World Communications Year : Development of Communications Infrastructures". The objective of the World Communications Year was to emphasize the importance of communications for economic and social development of our society. World Communication Year gave all countries an opportunity to review in depth their policies on communications development and to speed up the building of communication infrastructure. To help accomplish these noble goals, a

special fund was built up with voluntary contributions from governments and other organizations. The money collected was used for funding specific projects for infrastructure development at national and regional levels. To mark this occasion many countries issued special commemorative stamps and other philatelic items celebrating the year.

Mexico's World Communications Year stamp shown here features the symbol of the year with telecommunication instruments. In the field of telecommunications, satellites today one playing an important role it is visually reflected on the Sri Lankan stamp.

The World Communications Year

stamp of Canada features a symbolic multicolour globe surrounded by orbits suggesting the universal nature of communication and the impact of technical innovation. Papua and New Guinea issued four stamps depicting the various forms of communications.

Spain, Grenada, Brazil and India's World Communication year stamps featured the emblem and the sky, the satellite and the arrows that are meant to show visually the word "communications" as it is understood today : telecommunications through satellites crossing the skies and technical perfection leading to a better understanding everywhere in the Universe.

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FOLDING FLIERS

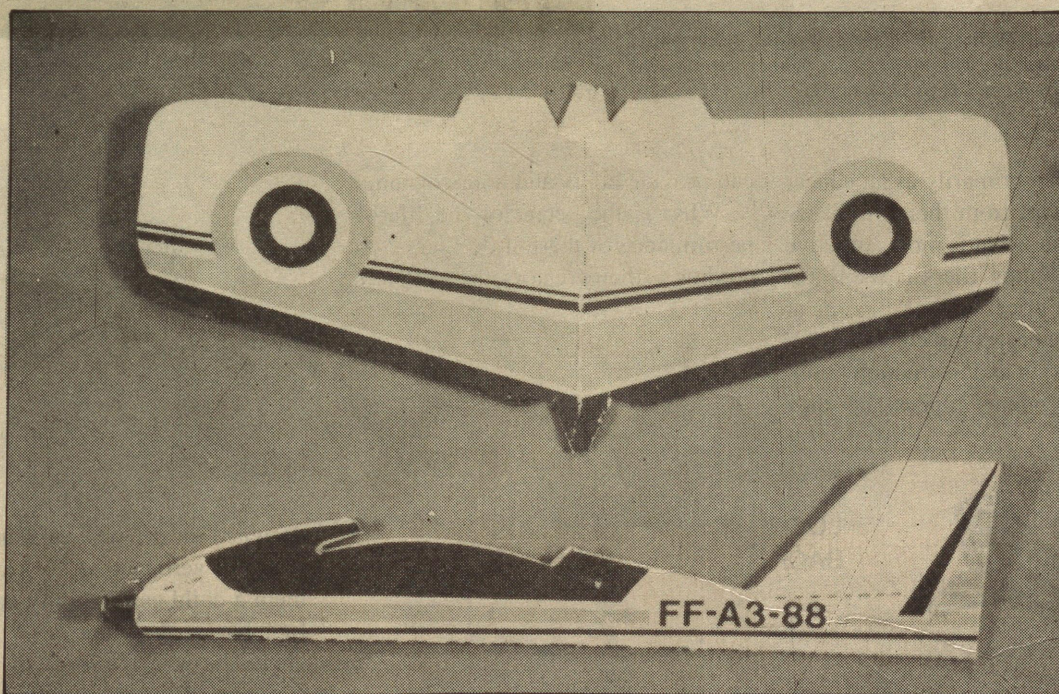
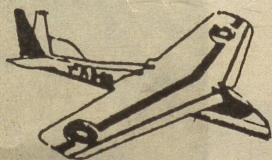
BIMAN BASU

IT may not impress you at first sight. Just a couple of pieces of folded thick paper cut into the shape of an aeroplane body and its wings—no more than a child's toy, you would think. But soon you are in for a big surprise. As the gentleman before you, who is also its creator, unfolds the folded pieces by delicately pulling at the two wing tips, a cute model aircraft takes shape. A couple of more foldings and a few adjustments here and there, and the model

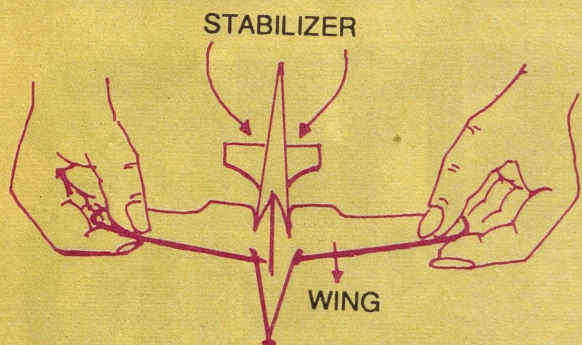
is ready for flight, you are told. But you are still skeptical. Could the thing really fly like a real one? You wonder. Sensing your puzzlement, the gentleman holds the model between his thumb and

forefinger and lets it go with a sharp jerk. And lo and behold, it not only flies off like a real one but also makes a wide loop around the room and returns back to the sender, as if controlled by an unseen pilot. You are left dumbfounded.

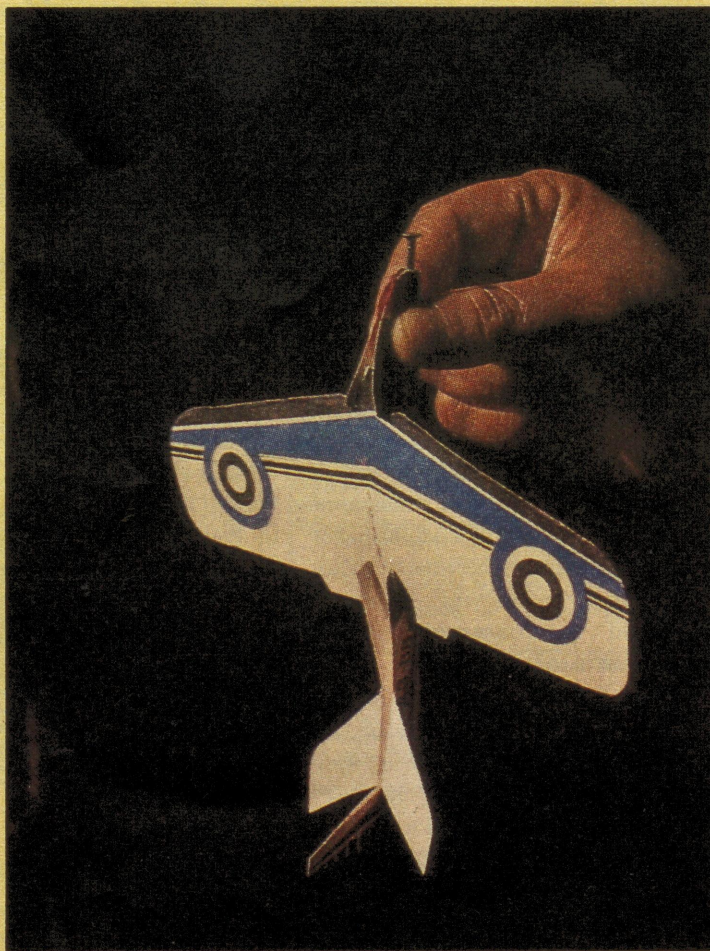
Well, this is no cock and bull story. Such paper aeromodels are indeed available, and they do fly almost like real planes. A brain-child of two entrepreneurs, Madhav Khare, and Ashok Padhye of the Science and Technology Park of Poona University, these models



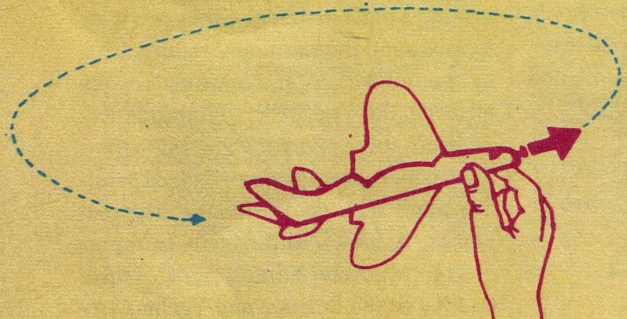
The folding plane, a teaching toy



To open the aircraft, hold the wing tips and pull them lightly on both sides. Also fold stabilizers to make them stay horizontal.



To launch the aircraft, hold its nose between the thumb and forefinger and throw with a sharp jirk.

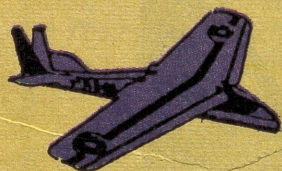
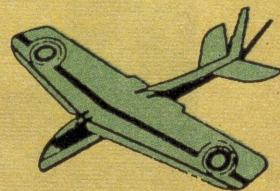


Making the aircraft fly back to you is a bit difficult, but quite entertaining. Adjust the wing-flops to the right or left, launch and try again. The plane will fly back to you.

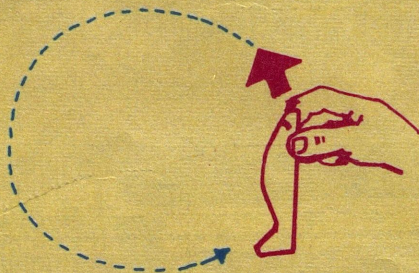
were developed primarily as an educational toy. Apart from their simplicity of construction, what is most attractive about these folding fliers is their surprisingly low price. A pack of four of these paper planes, complete with a 32-page information and instruction booklet, costs just twenty rupees. Yet they

can provide hours and hours of fun.

What is the secret of the life-like performance of these little fliers? According to their creators, the models are

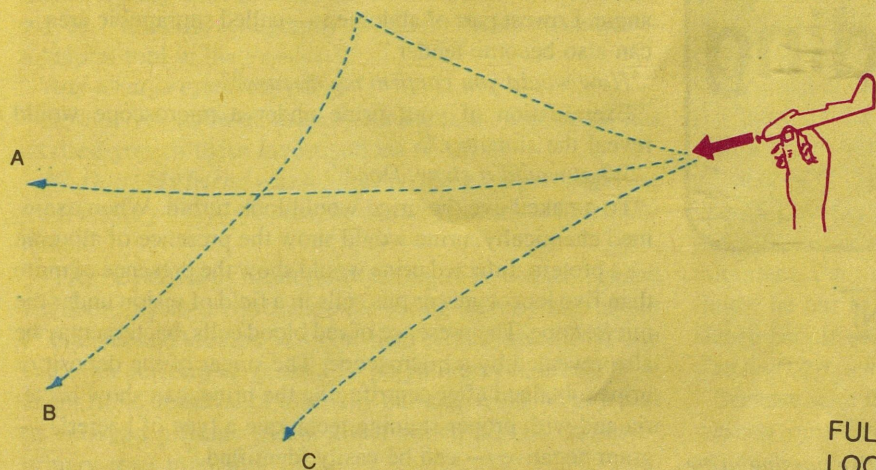


LOOP
BACK



Launching vertically towards the ceiling makes the plane to fly in a loop.

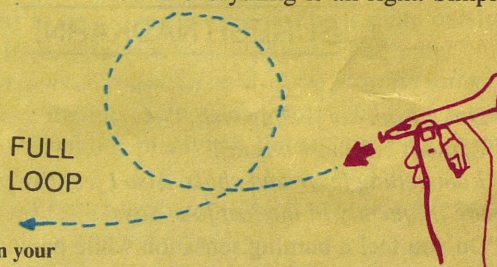
designed on the well-established principles of aeronautics. By playing with them a child can not only have lots of fun, but at the same time also learn about the aerodynamics of flight. He can even devise his own experiments with them.



Test flight. Once you have set the wings properly. Just hold the model by its nose between your thumb and forefinger and throw it forward as shown. If the model flies as in path 'A' you have got it ! If it follows a path as in 'B', its nose moment needs correction. Just pull the nail out a little and try again until you get the correct flight. If it flies like 'C', the stabilizers may be the cause. Fold them properly along the dotted line and keep them horizontal, it will work.

vature as in real plane wings. The stabilizers are then folded down to make them take up a horizontal position. A nail at the tip of the nose provides the necessary moment of force to keep the aircraft stable during flight. The nose moment can be altered simply by pulling the nail out or pushing it in a bit.

Once the wings and the stabilizers are in position a simple flight test would show if everything is all right. Simple

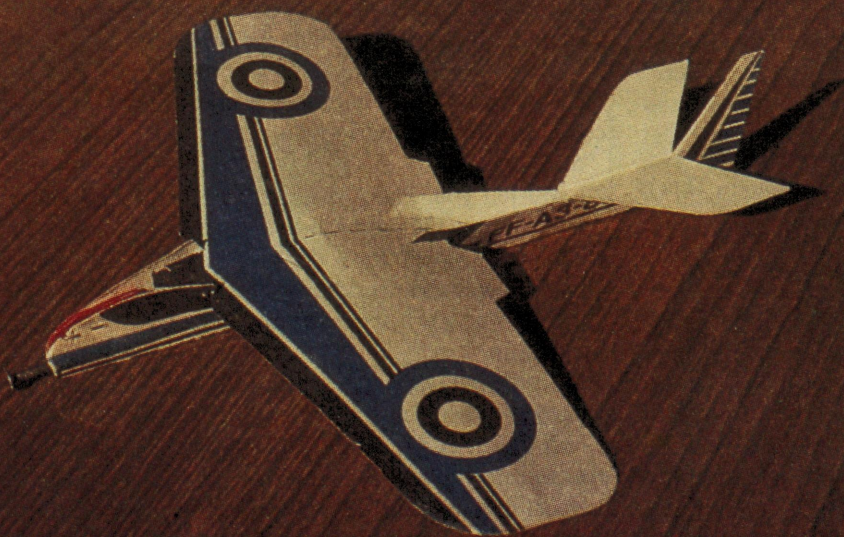


Looping flight of the folding plane

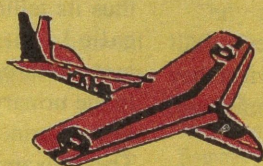
adjustments described in the accompanying booklet will help you to get a perfect flight from the model. It can even be 'programmed' to follow a predetermined flight path. It can be made to turn during flight simply by adjusting the ailerons at the wing tips. For example, if you want it to turn right, bend the right aileron slightly up and the left aileron slightly down. This is exactly what the pilot of a real plane would do. You can even make the model fly in a vertical or horizontal loop that brings it back to you. Of course it will need a little practice but it is

not difficult. Try it, and have hours and hours of fun !

The set is available from :
 Shastravahini, D-38, Vishnukripa Society, 1393, Sadashiv Peth, Baji Rao Road, Pune 411002. □



EACH flier is made up of two parts, the wing and the body, which includes the vertical fin and two small horizontal stabilizers. When the folded wing is opened by pulling at the tips, it automatically takes up an aerofoil cur-



Understanding UTI

SURESH NADKARNI

"Doc ! I am not feeling well. "

"Ramesh ! What's wrong?"

"I am getting fever and chills. Also I feel like passing urine quite frequently in the last four days..."

"Do you feel a burning sensation while passing urine?"

"Yeah Doc. I get pain in the flanks too!"

"Oh ! Your symptoms pin point to a diagnosis, Ramesh. Probably you have got urinary tract infection or UTI. When this infection is limited or is predominantly in the lower urinary tract, heaviness in lower abdomen is felt. Burning, while passing urine, is also an associated complaint."

"That means I am probably suffering from urinary tract infection. How do I confirm that?"

"How does your urine look?"

"It is turbid."

"This speaks for itself!

"Sometimes it is reddish. I feel that I am passing blood."

"You are right. Blood in urine could be a symptom. This is called gross haematuria in medicine. Did you have any severe pain in the abdomen?"

"No Doc ! But why this question...?"

"Because this pain is caused sometimes by an associated stone in the urinary tract."

"I feel I am passing little less urine."

"It may be on account of fever and vomiting. Did you vomit?"

"No ! But my appetite has gone down. I feel like vomiting at times."

"If this recurs and continues for a long time, some become quite weak also. Some get a headache — sometimes unexplained! "

"Why unexplained?"

"I will tell you. Urinary infection is caused by bacteria. Half of such infected patients do not have any symptoms. But they get headache. As they have no symptoms of infection, headache cannot be explained."

"In such circumstances, your clinical examination may help to diagnose."

"No ! Not always. On examination the only sign found may be a little tenderness in the flanks of abdomen or kidney-angle. Lowest part of abdomen — called suprapubic area — can also become tender."

"How would you confirm my disease?"

"Examination of your urine under a microscope would reveal the situation."

"What would it show, Doc?"

"To a naked eye the urine would look turbid. When examined chemically, urine would show the presence of albumin — a protein. Infected urine would show the presence of more than five leucocytes or pus cells in a field of vision under the microscope. The presence of red blood cells, bacteria may be also revealed by a microscope. The smear of the deposit or urine, obtained after centrifuging the urine, can show bacteria and with proper staining technique a type of bacteria — gram negative — can be easily identified."

"For more detailed knowledge of the bacteria, they culture the urine. Isn't it doc ? I heard it somewhere..."

"You are right. The culture not only shows the presence of bacteria, but tells us also about the antibiotics which would be effective against these bacteria. This is called antibiotic sensitivity test."

"This a good idea Doc! We get a ready weapon in the form of a proper antibiotic, which would kill the bacteria and cure the infection."

"Blood of the patient is also cultured. Occasionally the bacteria, circulating in blood, can be detected."

"Do you take X-rays, Doc?"

"Yeah ! X-ray is an important tool for diagnosing various conditions which predispose a person to the infection."

"Such as...?"

"I will tell you. Plain X-ray of abdomen or genitourinary tract can show the presence of a stone. Stone, as you know, obstructs or slows down the urinary flow. This partial or complete retention of urine allows bacteria to settle down and thus flares up a urinary tract infection. Sometimes they do a pyelogram."

"What is that doctor?"

"As you know, the urinary tract is not opaque to X-rays. Hence a plain X-ray does not show us clearly the structure of the urinary tract. X-ray examination, can reveal any anatomical structure only if there is a radioopaque material in the urinary tract. This material is called a dye, which is injected in the vein of the patients and in a very short time the dye enters the urinary tract and turns it opaque to the X-rays and thus its telling pictures can be obtained. This procedure is called intravenous pyelography. A micturating cystourethrogram is also done at times. A dye is introduced in the urinary bladder via this tube and the patient is asked to pass urine. While he is passing urine, pictures are taken. These examinations also reveal any birth defects in the urinary tract."

"And what is sonography Doc?"

"Good you asked! Sonography is a method in which picture of the urinary tract is obtained with the help of ultrasonic waves. Ultrasonic sonography (USG) is a recent technique—a helpful tool in diagnostics."

"And what is cystoscopy Doc."

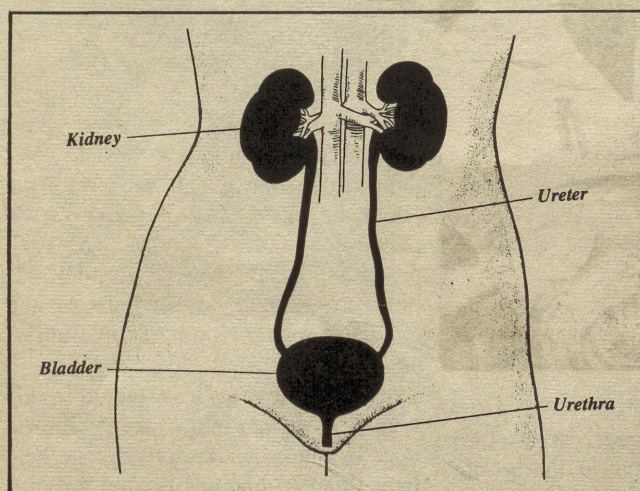
"How do you know all these terms Ramesh? Somebody has advised you all these investigations or what?"

"No Doc ! My friend was telling me. His grad-pa , suffering from urinary tract infection, has undergone these investigations."

"O.K. ! Cystoscopy means introducing an instrument, called fiberoptic cysto-urethroscope for seeing directly the insides of bladder and urethra. With the help of this instrument, one can even perform surgeries like polyp removal, crushing of small stone, removal of ulcers by burning, excision of a part of enlarged prostate gland, all of which can be causes of urinary tract infection."

"What about lithotripsy?"

"Oh ! Lithotripsy, that is crushing of stones with the help of



ultrasonic waves, is rarely required in urinary tract infection. However, stones, as I told you, if they are obstructing the urinary flow, lithotripsy may be used."

"One question constantly bothers me. Who gets this urinary tract infection?"

"A good question ! UTI mostly affects females. However, males also get it at times. In young males like you, UTI are rare."

"Why UTI are more common in females?"

"Short female urethra, plays an important part. In pregnant ladies also UTI are very common. People, suffering from diabetes, also complain of recurrent UTI."

"What would happen, Doc, if this infection is not properly treated?"

"UTI is always to be taken proper care of. Acute bacterial invasion of kidney-tissues can be hazardous, resulting in enlargement of the kidneys with small blister like swellings on it. This could also be fatal."

"O.K. Doc ! Tell me about the treatment now."

"General measures are very important. Drinking of plenty of fluids during the day is very helpful."

"How much water, Doc !"

"Plenty of fluids means not only water, but other fluids also like milk, butter-milk, Kanji-water, cold drinks, tea-coffee, sherbats, juices, tender coconutwater and so on. This is very important. I am stressing this because when a person takes fluids, he has to pass more urine and this is quite painful. Hence people are reluctant to drink plentiful of water."

"In that case, why do you insist on drinking plentiful water?"

"Because with the increased urinary flow, the bacteria are washed out. Drinking plenty of fluids is a part of the treatment."

"But Doc, Can't you suggest any tablets which would reduce the burning while passing urine."

"Of course, I can ! I will write it down for you, but only after proper diagnosis. Otherwise, in my experience, the relief offered by these surface-analgesic prompts the patient to stop investigations and stay away from proper and complete treatment of the disease."

"O.K. ! I will start on these tablets only on your advice. But could you tell me the name?"

"The chemical name of the tablet is Phenaxophridine hydrochloride. We also administer alkalis or alkalinizing syrups. Sometimes acidifying agents like methanamine mandelate or nitrofurantoin are used. This is decided on the basis of the acidity or alkalinity of urine. Acid urine is made alkaline or vice versa, as it has been observed that by changing the pH of the urine, organisms can be killed."

"And, what about antibiotics?"

"That is the last weapon I use. Ideally urine culture and antibiotic-sensitivity tests should be done, as I told you. However it's prohibitive cost prompts the doctor to use the antibiotic of his choice, derived out of his valuable experience."

"O.K. ! Doc ! Now tell me, what I should do?"

"Get your urine examined first..."

"Which urine?"

"Morning sample ! The first urine which you pass after getting up from the bed. This urine is to be collected in a clean bottle."

"Till then?"

"Only plenty of fluids!"

"Thank you Doc ! I will do that..."

Dr. Nadkarni is a practising physician. Address : 5th Floor, Flats No. 38-39, Municipal Building, Jobanputra Compound, Nana Chowk, Bombay-400 007

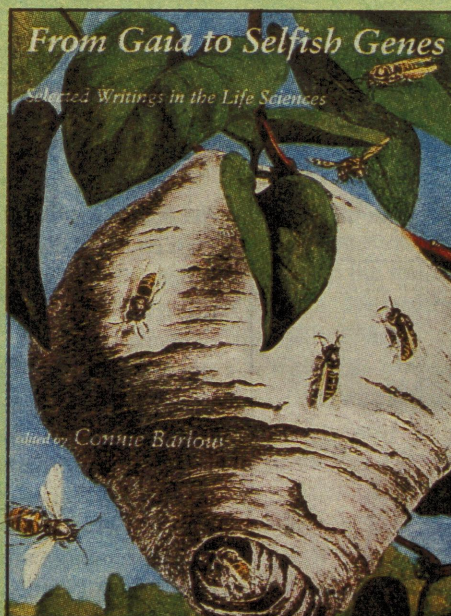
The Living Earth

OUR understanding of the biological world has undergone sea change during the past few decades. However, most of the new discoveries are so complex that understanding them is beyond the ken of not only the man in the street but scientists from other disciplines as well. Fortunately, there are a few scientists and writers who have perfected the art of communicating the thrills of the new discoveries in layman's language. Selected writings of more than 30 such authors have been put together by editor Connie Barlow in this excellent anthology*. Among the authors whose writings appear in this volume are such luminaries as Robert Axelrod, Francis Crick, Richard Dawkins, Stephen Jay Gould, Julian Huxley, Arthur Koestler, Lewis Thomas, and E.O. Wilson. It is, however, no mere collection of articles. Barlow has painstakingly edited them and, with his own and other scientists' comments and annotations, strung them together into seventeen well-knit chapters.

The opening chapter, as the title suggests, is on the Gaia theory first propounded in the 1970s by the British scientist and author James Lovelock. He projected the Earth as a living entity, its biosphere as a self-regulating system with the capacity to keep our planet healthy by controlling the chemical and physical environment. But for most scientists it was a concept they found difficult to accept. "How in the world could the bacteria, the trees, and the animals have a conference to decide optimum conditions? How could organisms keep oxygen at 21 per cent and the mean temperature at 20°C?" Not seeing a mechanism for planetary control, they denied its existence as a phenomenon and branded the Gaia hypothesis as teleological.

Yet it was not dead. There were scientists, like Lewis Thomas, who in

his award winning book *The Lives of a Cell* published in 1974, called the atmosphere "the world's biggest membrane". By the time his collection of essays, *Late Night Thoughts on Listening to Mahler's Ninth Symphony* appeared in 1983, he had adopted Gaia as more than a metaphor. He wrote, "The overwhelm-



ing astonishment, the queerest structure we know about so far in the whole universe, the greatest of all cosmological scientific puzzles, confounding all our efforts to comprehend it, is the earth. We are only now beginning to appreciate how strange and splendid it is, how it catches the breath, the loveliest object afloat around the sun, enclosed in its own bubble of atmosphere, manufacturing and breathing its own oxygen, fixing its own nitrogen from the air into its own soil, generating its own weather at the surface of its rain forests, constructing its own carapace from living parts: chalk cliffs, coral reefs, old fossils from earlier forms of life now covered by layers of new life meshed together around the globe, Troy

upon Troy.

Seen from the right distance, from the corner of the eye of an extraterrestrial visitor, it must surely seem single creature, clinging to the round warm stone, turning in the sun."

The expression of the second part of the title appears in the form of excerpts from Richard Dawkins' book of the same name. "Rather than bog ourselves down in details, can we think of any universal qualities which we would expect to find in all good (i.e. long-lived) genes? Conversely, what are the properties which instantly mark a gene out as a 'bad', short-lived one? Any gene which behaves in such a way as to increase its own survival chances in the gene pool at the expense of its alleles will, by definition, tautologously, tend to survive. The gene is the basic unit of selfishness".

Nobel Laureate Francis Crick preferred to use the term 'selfish DNA' for Dawkins' selfish gene. But author Stephen Jay Gould challenged some aspects of the broader selfish gene theory. "Selfish gene", he wrote, "is about the worst possible name for the phenomenon, for it records the very prejudice that the new structure of explanation should be combating: the exclusive focus on bodies as evolutionary agents."

Among other topics covered in this highly readable volume are symbiosis in cell evolution, hierarchy theory, systems theory, gene theory, and sociobiology. There is also a scattering of autobiographical passages and biographies, which bring out the human side of research, often revealing the social context and interactions. Illustrated with several thought-provoking works of art by well-known artists, the volume will be a valuable addition to any book lover's collection.

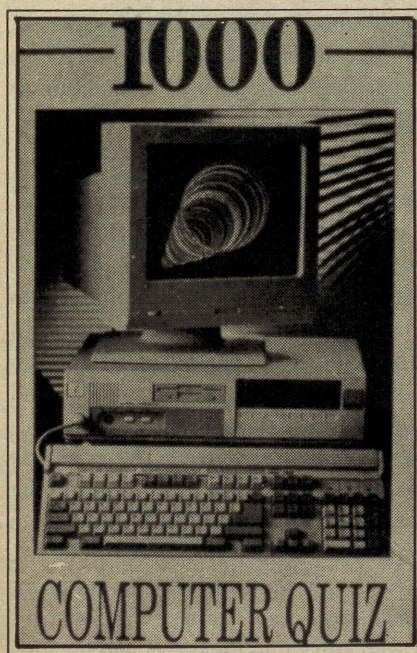
***FROM GAIA TO SELFISH GENES: Selected Writings in the Life Sciences**, edited by Connie Barlow, *The MIT Press, Massachusetts Institute of Technology, Cambridge, Massachusetts, 02142, USA.* (1991), Pp. 274 \$ 17.50

Biman Basu

1000 COMPUTER QUIZ by B.L. Theraja and Pankaj Theraja, *Rupa & Co.*, 7/16, Ansari Road, Daryaganj, New Delhi-110002, Pp.167, Rs.30.00.

COMPUTERS now seem to be ubiquitous making their headway in our professional as well as personal lives.

They have been finding place in homes, offices, schools, hospitals, banks, factories and even battlefields. In order to be successful and cope with the technological developments in the modern world one undeniably has to be computer literate. Basically, computer lit-



eracy means knowing what a computer can and cannot do. The main purpose of the book under review, which contains 1000 computer quizzes, is to help people become computer literate.

Presented in a multiple-choice format, the quizzes take the readers to the enigmatic world of computers. The quizzes cover a wide range of topics including computer hardware and software, input and output devices, programming languages, supercomputers,

mini and personal computers, artificial intelligence, computer viruses and robots. The use of computers in medicine, education, animation, arts and games, are also covered through various informative and well-framed questions. The book also covers such topics as crime by computers and impact of computers on society.

Interesting facts and some pieces of fascinating information about computers are also incorporated. The book mentions an interesting fact about a gentleman in the computer industry who became the world's youngest billionaire at the early age of 31. Do you know, by the way, who are the "animals of Silicon Valley", who are *silico sapiens* and what is meant by wetware? Further, have you any idea about the IQ of a modern digital computer and that some people suffer from cyberphobia which is nothing but the feeling of fear of computers? Have you heard about computer 'bug' and computer mouse? One needs to leaf through the pages of the book in order to get answers to these and many other interesting questions.

P.K. Mukherjee

"WE CAN BUILD YOU" by Philip K. Dick, *Grafton Books*, (Available from *Rupa & Co.*, Daryaganj, New Delhi-110002). Pp 252, £1.95.

ROBOTS and androids have been an oft-repeated theme in science fiction stories and novels and almost every science fiction writer worth his salt has dabbled in robots at one time or the other. The earliest of these were constructed of flesh and bone, what would now be called androids and only later were they made of metals. The idea that if you built it, it couldn't be good carries on through C.C. Campbell's 'The Avatar' (1935) where the perfect artificial man becomes dictator of the world and has to be destroyed.

The book under review is a story of robots. The author prefers to call them simulacra. Louis Rosen and Maury Rock are partners in a company called MASA Associates which specializes in building electronic musical organs. Bob Bundy is their technical expert. Because of fierce competition from other organ factories, their business starts faltering and Maury Rock comes up with the idea of building simulacra. Only much later does the reader discover that the idea has basically sprung up from the mind of Maury Rock's psychotic daughter Priscilla Frauzimmer.

She is under the influence of a millionaire Sam K. Borrows who wants MASA Associates to build millions of simulacra. Their simulacra built under the guidance of Bob Bundy look exactly like humans and till their 'power' is on, one is not able to differentiate between them and actual humans.

Borrows has bought land on the moon in the anticipation that the land price on moon would shoot up and he would make profit out of it. However no one wants to buy on the moon and he finds his millions of dollars sinking. It is at this juncture that he comes up with the idea of simulacra. The plan is that he would buy these simulacra from MASA Associates at ridiculously low rates and would then transport them to moon. Seeing that many humans (actually simulacra) have gone to moon, humans would shed their inhibitions and would start buying land on the moon. Prices of land on moon would shoot up and Borrows would fish out his profits.....

Robots have certainly been put to an imaginative use in this novel but unfortunately Dick's simulacra don't obey Asimovian laws of robotics. This becomes very irritating at places. The novel is extremely slow paced and lacks grip. Lot of American slang is used which a novice might not well appreciate. What's more disappointing is that Dick, in an effort to compensate for the slow pace, puts in sprinklings of sex,

which at several places becomes too heavy-to the extent of becoming unsavoury and disgusting.

It is quite disappointing that Dick has resorted to such tactics in an SF novel. He was in fact a good writer and has done such fine works as *The Man in the High Castle* (1962) and *Do Androids Dream of Electric Sheep?* (1968). The book under review was written towards the fag end of his career (he died in 1982) and predictably enough shows signs of decadence. Certainly not one of his best books.

Anil Aggarwal

NIGHTFALL by Issac Asimov and Robert Silverberg, *Pan Books Ltd.*, (Distributed by *Rupa & Co.*, 7/16, Makhan Lal St., Daryaganj, New Delhi-110002), Pp.352, £ 2.20

THE enchanting element of a sci fi story is its idea content and intellectual richness. Robert Silverberg brings this out vividly and successfully on an Asimov's idea. Asimov wrote "Nightfall" as a short story in 1941. The novel *Nightfall* is its expanded form by Robert Silverberg. Silverberg's thoughtful expansion of the story is certainly a worthwhile and valiant attempt.

The original concept and the content of the story were developed by Issac Asimov probably in consultation with John W. Campbell Jr., Editor of *As-tounding Science Fiction*. When it was published in 1941, it became a classic Sci Fi of its time establishing Asimov as a writer of distinction. Silverberg realized that the story had the potential to be developed into a novel of 12 thousand words and so extended the plot. Now the original and extended story form the central section of the novel; the first being "twilight" and the last 'Daybreak'. Sci fi lovers and Asimov fans must have already read the famous short story sometime in their life, yet reading the

novel can be a pleasure.

The story of *Nightfall* is by all means captivating. If the growth of the European society is investigated, it looks as though Asimov has taken "Nightfall" straight out of the vaults of history. The Church and religion and its association with the advancement of scientific ideas in Europe are reflected in the story.

The characterisation in this novel is very strong. The story leaves a profound impact on the mind of the reader. Finally, the readability, idea content and literary merit of the *Nightfall* have already been established to be of a very high order years ago.

Ranbir Singh

SASSINAK : THE PLANET PI-RATES VOL 1 By Anne McCaffrey and Elizabeth Moon, Orbit Books (Distributed by *Rupa & Co.*, 7/16, Makhan Lal Street, Daryaganj, New Delhi-110002. Pp.333, £ 4.50.

THE science fiction under review is the joint effort of two authors and it is to their credit that the narrative flows smoothly. The storyline is simple.

Sassinak, the heroine of the novel is twelve when interplanetary pirates trick the security network of her home planet Myriad and devastate it. Her family and most of her friends die in the massacre and she is taken captive. As a slave she is trained to increase her sale-value and then sold as an apprentice pilot to another pirate ship. Unknown to her captors, another slave, an ex-Fleet patron crewman has implanted vital information in Sassinak's mind. Her pirate ship is intercepted by cruising Fleet patrol and under expert interrogation Sassinak divulges information that leads the Fleet to the private stronghold which means a second lease of life for our heroine.

Returned to the Federation of Sentient Planets (FSP) she is adopted by Abe, the ex-Fleet crewman and now

freed slave, she joins Fleet as a raw recruit going through all the ordeals that the training entails.

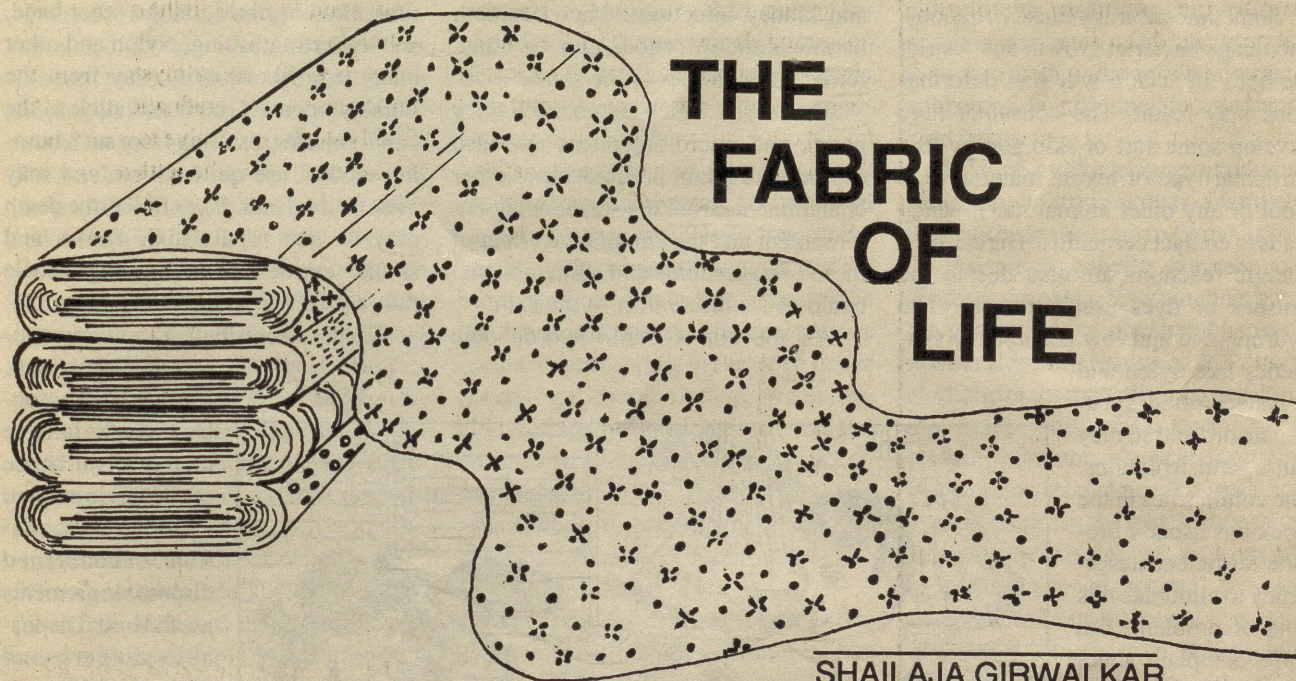
Abe is killed under mysterious circumstances on her graduation day but this only steels her resolve to end piracy which endangers all the settled colonies on the far flung frontiers of space. The story details her rapid rise to senior rank and her friendships with humans and aliens as well as enmities that buffet her and almost cost her life.

It is a soft science fiction story rather like an old-fashioned western, with the lone, bitter hero with a chip on his shoulder and the fire of revenge that keeps him going. Fast-paced action is the leitmotif of novels of this genre. In the one under review also the action never flags enough for the attention to waver.

There is an assortment of alien races, the form changing-mind reading wefts, the almost mineral Theks, the sessile adult Ssli which has extraordinary powers of detection, the feathered Ryxi, to mention a few. Together they interact in a fantastic world but the end results are not very unexpected. There is love and friendship, hatred, deception, destruction, sabotage and greed. There are acts which fuel vengeance that become the reason for survival. The languages are different too, namely, Standard, Harish, Neo Gaeah. Surprisingly, of our known languages, only Chinese has been allowed entry into the novel and the citizens are all vegetarians because they fear eating sentient life-forms.

The end is sufficiently tantalising with Sassinak unearthing a saboteur on her ship and forming a planet-pirate breaking team with her great-great-grandmother rescued from coldsleep (which is a kind of predetermined self-induced coma). Readers will avidly search for the subsequent novel in the series which should, if this one is any indication, be equally pleasurable to read.

Sukanya Datta



SHAILAJA GIRWALKAR

Textiles, both natural and synthetic, have endless utility in all fields of life. From the day one is born to the day he breathes his last, a person finds fabrics immensely useful every moment of his life. Clothing is the second skin that forms the body's almost constant protection from the environment. The textile material not only protects the individual from the extremities of climate and accidents, but also satisfies many of man's social, psychological and physical needs. Many a time the air inhaled in modern buildings, institutions and houses are filtered through a number of layers of filters often textile in nature. The cold and soft beverages and even the hot ones are filtered at some stage of their manufacture. Textile filters reduce the smoke expelled into the atmosphere and reduce effluents emitted into rivers, oceans and streams.

But when an issue on human health and well being is considered, discussed or viewed, the important role played by textiles is completely ignored or over-

looked. However, the relationship of an individual with textiles and the role of textiles in the well-being of an individual is quite fascinating.

Advances in scientific knowledge proved long ago that skin, one of the five sense organs, is quite alive. It respire exchanging air through numerous tiny, invisible pores present all over it. Because of respiration, the body is kept warm. Cold air, strong emotions, tensions, mental strain and stress can close these pores and the breathing through skin gets disturbed.

Apart from breathing, skin also helps in regulating the body temperature and controls the loss of moisture from the internal organs.

In this context, textiles play an important role allowing the diffusion of heat and moisture from the surface of the skin. A number of studies have compared the insulating capacity of various fabrics and their ability to permit the body water vapour to pass through. In other words, these studies focused on the comfort that the textile materials provide under varied atmo-

spheric temperature and relative humidity.

There are a number of man-made fibres being synthesised by utilising more than 5,000 chemical compounds directly or indirectly. Of these, many are volatile, get evaporated easily and readily.

These chemicals used in the manufacture of synthetic fibres are derived from the destructive distillation of petroleum. Various chemicals, either in dilute or concentrate form, are essential at all stages of the manufacturing of fabric. Many natural fibres are also treated with some or the other chemical in order to improve their appearance or incorporate a special property. For instance, scouring, bleaching by chlorine, resin finishes to give gloss, and so on. Such being the case, the potential for health hazard exists not only for the textile worker handling the chemicals directly but also for the consumer, who ultimately uses the textile product. Chemicals, many of them volatile, may be toxic (carcinogenic) or affect the organs specifically (hepatic, nervous

system, circulatory system etc).

Sometimes textiles cause irritations, encourage bacterial growth and restrict the body in such a way that deformations may result. The consumer may develop some sort of skin allergy to a particular type of textile material (e.g. wool or any other animal hair), which leads to contact dermatitis. The cause of allergic reactions are also due to the finishes or dyes used on them. The hydrophobic and low absorbency synthetics like nylon and polysters often accumulate dirt and so may cause skin irritations. The cotton soles in the stockings usually provide sufficient absorbency to eliminate this kind of problem. But some complain about irritation which is due to disease bearing organisms like bacteria, fungus, virus etc., that breed excellently due to lack of ventilation, warmth or moist condition. The glass fibre which has the best insulating property, tends to cause mechanical irritation due to its sharp and pointed ends. The apparels made from rubber of spandex (elastic) cause

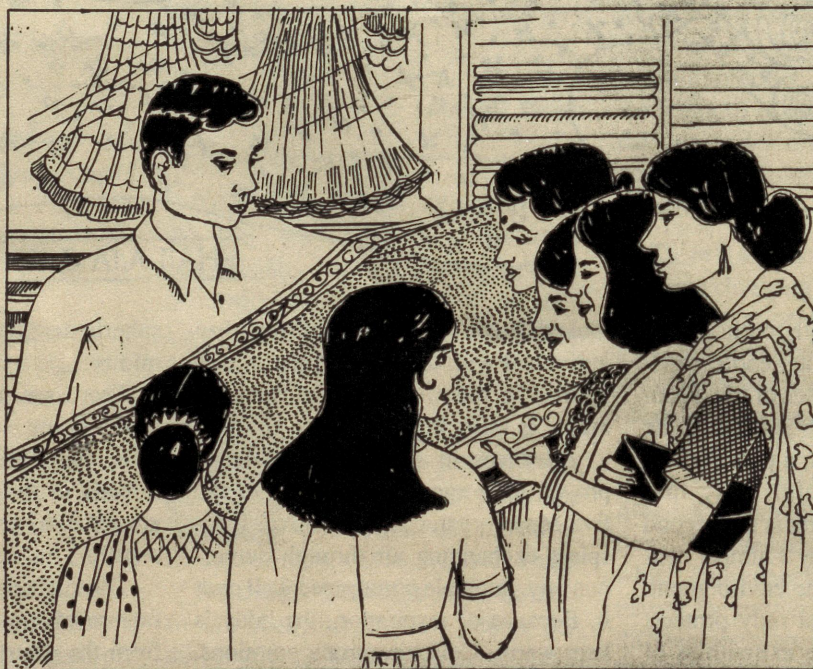
dermatitis which is due to the chemicals used in the processings. The irritations and skin problems are also associated with the soaps, detergents, softeners and the solvents used in the dry cleaning process.

Soiled clothing often contain large number of microbes and remain alive for a long period of time. Researchers have found that around five million bacteria per square inch are observed in the under-arm area of T-shirts. Many of these micro-organisms are harmless but few like *Staphylococcus* and *Pseudo-*

monas cause skin lesions, pneumonia and kidney infections. Microbes both harmless and infectious may be transferred from clothes to the skin.

The fabrics which are good traps for germs and micro-organisms can also capture and retain pesticides and other contaminants from the surrounding environment and the cumulative effect of these two (pesticide and contaminants) could cause discomfort to the skin.

All the non-wettable hydrophobic



Fabrics make a person look better and feel better

fibres (e.g. nylon and polyster) build up static electric charges on their surfaces. Sometimes to such an extent that they become good spark generators. In presence of ignitable gases like the cooking gas an explosion can occur (provided the spark contains sufficient energy). Even when the static charges are weak and do not cause any fire, they can still cling to the body, raise the hairs and cause discomfort.

Almost all the textile fibres can catch fire and some are highly inflammable. Some like the cotton fabrics burn with

large yellow flames for quite a long time. Protein fibres, on the other hand, are self extinguishing. Nylon and other man-made fibres, curl away from the flame on contact, melt and stick to the body. Injuries resulting from such burning clothes are quite severe and may even cause death. Sometimes, the death may be due to the toxic fumes and smoke emitted from burning textile rather than due to the burn injury.

Textiles contribute to environmental pollution too. Various health problems may be felt due to this disturbance of the environment.

As far as sanitation is concerned disposable garments are the best. Disposable diapers and sanitary napkins and hospital gowns are highly recommended. They are hygienic, no doubt, but can still be troublesome. Studies conducted in America reveal that the use of disposable diapers along with their filth contribute to around two percent of the total volume of wastes dumped into the

land fills each year. It is not the number of diapers disposed of but the amount of filth they carry into the land fills that constitutes the health hazard. A study by American scientists S. Steger and Bower Master showed that more than 2.8 million tons of excrement and urine are dumped into land fills every year. The faeces and urine may contain more than hundred different types of viruses, including polio and hepatitis. These diseases spread through ground water or by flies.

A study on 'Consumer Health Influ-

enced by Clothing and Household Fabric' was conducted in five states of America, as part of an agricultural experiment. In this study the research workers assessed how many people in the population perceived that skin health problems were due to textile products. The results showed that 29.2 per cent of the population perceived such 'textile and health' related problems. These problems were more evident in women between age group of 20-35, living in cold and dry climates. It was also found that allergic dermatitis was a result of exposure to 'disperse dyes' and finishing agents containing 'formaldehyde' used in fabric manufacturing. Some persons experienced eczematous skin conditions too.

Pesticide contamination and safety of workers was undertaken to find out the effect of fabric on skin contaminated with pesticide. About millions of pounds of agricultural chemicals are handled by workers to control the insects, pests, and weeds each year, in the United States. It is known that the expo-

sure of skin to toxic pesticides can be minimised to a great extent by use of protective garments. Many times, the pesticide gets trapped through the fabric structure, hence care must be taken to remove this pesticide before the garment is used again.

Considering the hazards that clothings carry with them, efforts are on to make clothes completely free of any germs. Earlier approaches to make them more hygienic was to boil or autoclave the fabric and kill the disease causing organism and drying in the open under the sunlight, to some extent, as a germicide. But today, many antibacterial and antimicrobial chemicals are applied on the cloth during the finishing stages of manufacture to prevent the growth of microorganisms and inhibit molds and mildew growth.

Sweat, when secreted from the body is odourless, but gets ammonia like odour on absorption by the textile material where bacteria decompose it. Therefore, antimicrobial treatment is given to keep the garment smelling

fresh. The antibacterial finish is also applied to diapers, sheets, bed covers, pillow covers, mattresses, surgical packs and even the space suits. Unfortunately it is found that the effectiveness of antibacterials is diminished on repeated laundering.

Role of clothing in psychological well-being is very important. Many studies have been taken up to throw light on the therapeutic benefits of clothing for illnesses, impact of clothing in altering the perceptions of physical handicaps, relationships of clothing to self esteem, clothing for the mentally retarded, clothing design for handicapped, elderly women, common physical limitations and clothing related needs. Good clothing can diminish the appearance of certain physical disabilities and thus help in getting a good societal response. Clothing, self esteem, social acceptance and social participation are all inter-related.

Dr. Shailaja is an Associate Professor, Department of Textiles, R.H.Sc. College, Dharwad - 580 005

TO OUR CONTRIBUTORS

SCIENCE REPORTER welcomes articles of absorbing interest on science and technology. Contributions published in the Journal will be paid for.

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- The form and manner of presentation of the subject should be easily understandable to the undergraduate level.
- The length of the article written exclusively for the Journal, may be about 2500 words.
- The matter should be typewritten, double space on one side of the paper; the original and a carbon copy are to be sent.
- The article should preferably be illustrated; captions and legends typed separately and attached at the end of the article. Photographs should be on glossy paper of at least 10 cm×15 cm size.
- While quoting names of scientists, etc., their initials, nationalities and periods of research under reference should invariably be mentioned. All weights and measures should be given in Metric Units.
- A short note about the contributor should also accompany the article. The note should contain age, academic accomplishments, important assignments held, field of research and hobbies.
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POLYMER COMPOSITES FOR LIGHT WEIGHT CARS

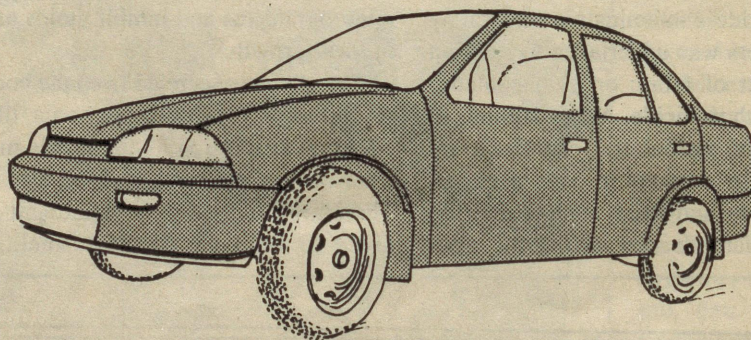
SUBBIAH ARUNACHALAM

IN a concerted effort to restore American competitiveness in automobiles, Ford Motor Company's Research Laboratory in Dearborn, Michigan, and the General Electric Company's R&D Centre at Schenectady, New York, are mounting a joint five-year, 10.8\$ million venture that would eventually make it possible to manufacture structural composite parts for automobiles from cyclic thermoplastic polymers.

Such composite structures are expected to be very strong at about a third the weight of steel. The reduction in

flow into the spaces surrounding a composite's reinforcing fibres, even under high pressure.

In cyclics technology, one starts with thermoplastic materials having a ring or cyclic molecular structure. Such compounds usually have very low melt viscosities, and they flow easily — almost like water — when heated. Thus, these plastic materials can wet out and impregnate the composite's reinforcing medium. Once the wetting is over, special 'initiators' trigger a polymerization reaction that rapidly transforms the rings into long, linear molecules that give thermoplastics their characteristic



weight will obviously be reflected in gains in fuel efficiency.

At the heart of the research effort is the "cyclics technology" developed by General Electric scientists, which, for the first time, makes it possible to use engineering thermoplastics in high-speed, low-cost composite manufacturing processes required by the auto industry. Up till now, engineering applications of thermoplastics have been limited to their use in costly low volume aerospace applications, such as fighter aircraft components, because of their high melt viscosities, which make processing extremely difficult. When heated for moulding, the consistency of thermoplastics is like that of cold molasses, making it difficult to get them to

strength.

Ford and GE plan to use a recyclable cyclic ester which has excellent damage resistance and good processing characteristics. The material is also extremely resistant to common automotive solvents, such as petrol and brake fluid.

The Ford and GE scientists expect that their efforts would culminate with the fabrication of a generic automotive structural part under conditions suitable for volume production. The process, once ready, will be made available to other US auto manufacturers under the Advanced Technology Program of the US Department of Commerce.

Dr. Arunachalam is an Information Scientist at the CECRI, Karaikudi, Tamil Nadu

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Workshop On Science Reporting In Hindi

SCIENCE FOR THE MASSES

SCIENCE reporting cannot be restricted to the reporting of S&T news. Since journalism includes the whole gamut of reporting on latest technologies, for instance, computers, satellites, fax, etc, critical analysis of scientific issues, and all such science news that helps develop the scientific temper should also be reported. The aim of science journalism is to help the people learn how to see themselves and their society more clearly, to think about their problems more critically and to try to cope with them more intelligently and creatively. However, much still remains to be done to promote science journalism in Hindi.

In an effort to analyse the status of science journalism in Hindi and to give it an impetus, a three-day workshop on science reporting in Hindi was organised by the Makhanlal Chaturvedi Rashtriya Patrikarita Vishwa Vidhyalaya, Bhopal from June 18-20, 1992. Twenty journalists from all over the state actively participated in the workshop. The Madhya Pradesh Council for Science and Technology provided useful support.

While inaugurating the workshop the state minister for science and technology in Madhya Pradesh Shri Brij Mohan Agrawal emphasised that scientists should devote more time to research solving the day-to-day problems of the masses. Science and technology can certainly upgrade the standards of living in the villages, he added. Shri agrawal called upon the journalists to present more science news in their news papers in the language easily understood by the neo-literates.

Dr. G.P. Phondke, a noted science writer and Director, Publications and Information Directorate, CSIR, while speaking on the topic 'Science and

BRIJ MOHAN GUPTA

Common Man' said that science and technology has influenced the entire day to day life of the common people. The communication technology has reduced the globe into a small village. Farmers, housewives, artisans and labourers alike are today enjoying the fruits of science and technology.

Dr. Phondke emphasised that as the common man is the tax payer he has got every right to know about the objectives and progress of the research being done by the scientists. The journalists should keenly observe and present the S&T reports for the benefit of the masses.

Dr. D.R. Sharma, former Vice-Chancellor, Vikram University, Ujjain spoke at length on the topic 'Science and Philosophy'. He emphasised that while discarding the old beliefs and traditions care must be taken to analyse them rationally, otherwise science would itself create new superstitions and dogmas.

Dr. Man Mohan Singh Viradi, Project Officer, Polytechnology Transfer Centre, (CSIR), Bhopal informed the participants about the various low cost technologies developed by the CSIR National Laboratories. He was of the opinion that the media was not giving the proper exposure to the new indigenous technologies.

Shri Manoj Patariya, Senior Scientific Officer, NCSTC, New Delhi highlighted the history of science journalism in Hindi. Shri Patariya said that science journalism in Hindi sprouted about 175 years ago with the publication of a bilingual magazine — *Digdarshan*. The *Bharatbandhu*, *Sarswati* and magazines like *Vigyan* continued the campaign for popularising science. it is sad that despite these

sincere efforts science journalism did not flourish in Hindi.

Shri Arun Bhargava, Secretary General, Science Centre (Gwalior), Madhya Pradesh while narrating his experience in popularising science among the masses said that the general level of awareness about science is very poor. The media should come forward to inform, educate the entertain the masses through and about science. Shri Bhargava said that a campaign launched by the Science Centre (Gwalior) to explain the scientific basis of miracles is a landmark in itself.

Shri Rajesh Utsahi, sub-editor of the popular children's science magazine 'Chakmak' expressed the opinion that the children's columns in the newspapers were not being fully exploited for disseminating science. Efforts could be geared up for the same, he felt.

Shri Radhe Shyam Sharma, Director General, Makhanlal Chaturvedi Rashtriya Patrakarita Vishwa Vidhyalaya in his welcome address rightly pointed out that in this era of specialisation science journalism in vernacular languages is also to be specialised.

During the three-day-long workshop the participants surveyed the files of five local dailies and were surprised to find that despite the Global summit only 0.25 to 6.25 per cent space was given to science news. The content analysis, science reporting exercises, interviews and group discussions were the other highlights of the workshop. The workshop recommended that regular courses in science journalism may be started by the Vishwa Vidhyalaya. The editors should be motivated to provide more space for science and science reports should be inducted into the editorial teams.

Shri Gupta is a Programme Executive, All India Radio, Shirdi-473551.

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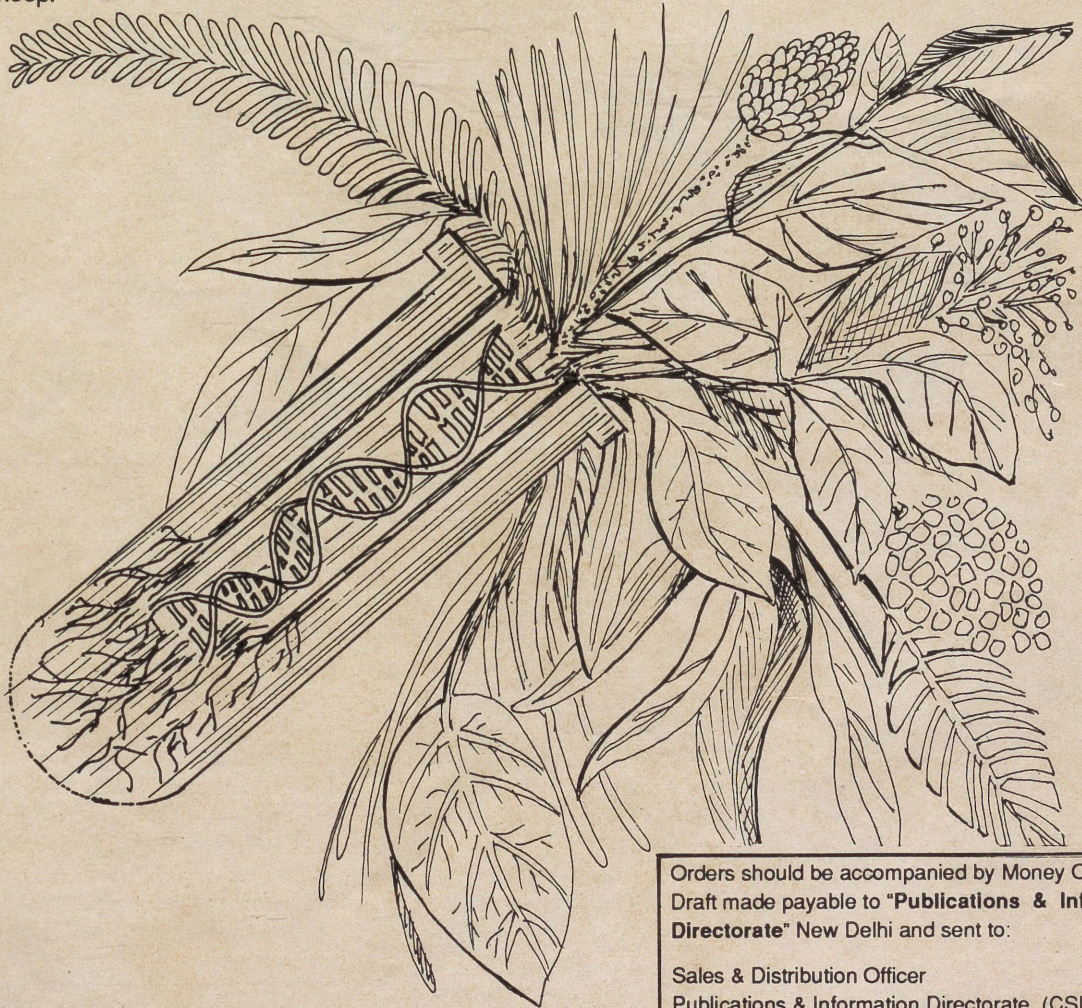
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