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MAY 1986
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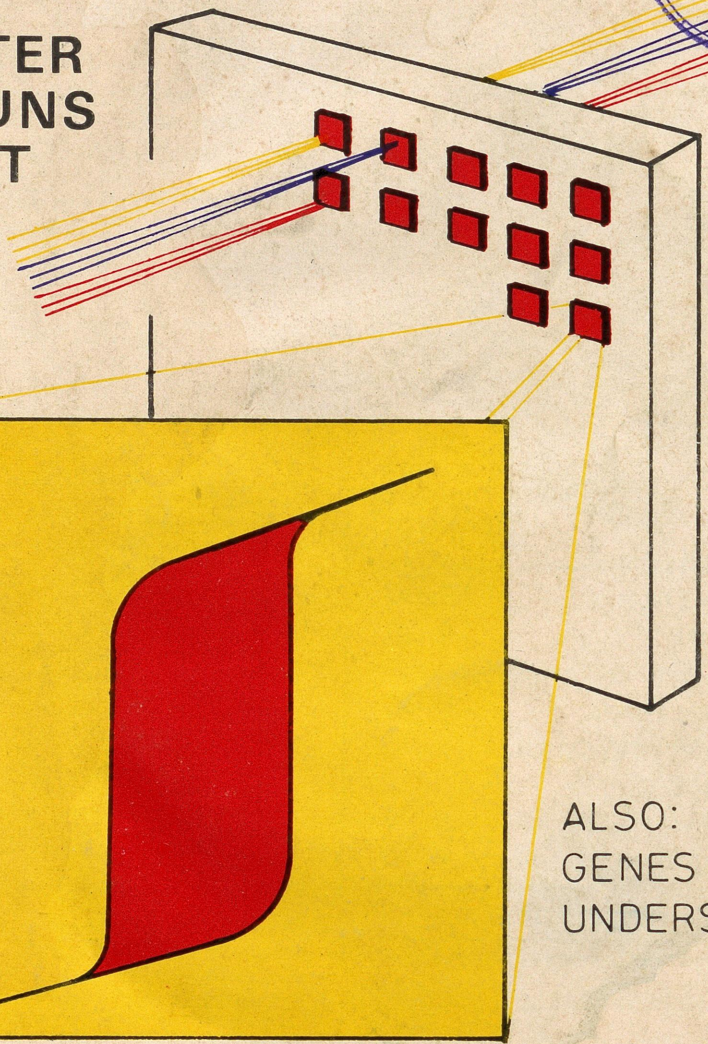

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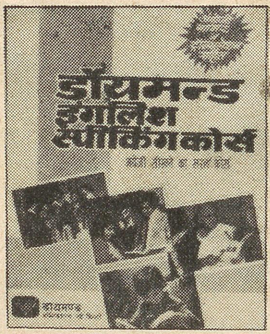

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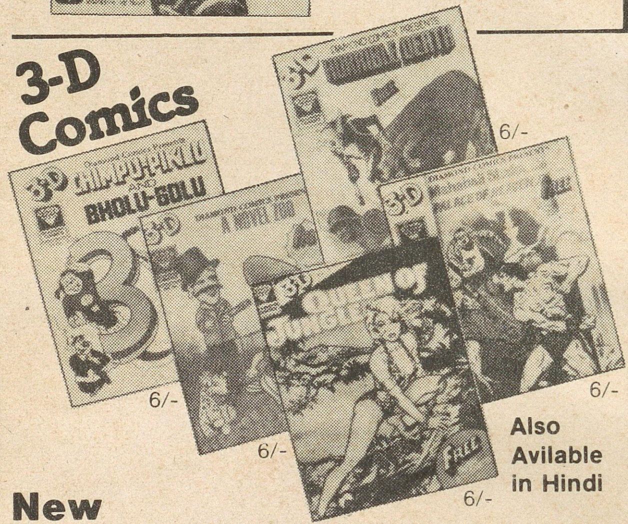

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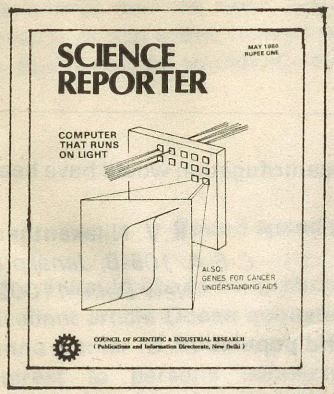

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LETTERS

Biotechnology

Sir, In the article **What can biotechnology do for us?** (*S.R.*, March 1986), the schematic diagram depicting gene cloning to produce insulin is incomplete and may confuse the minds of young readers. Given in Fig. 1 is a simplified illustration, with necessary details which I think should be understandable to the undergraduate level.

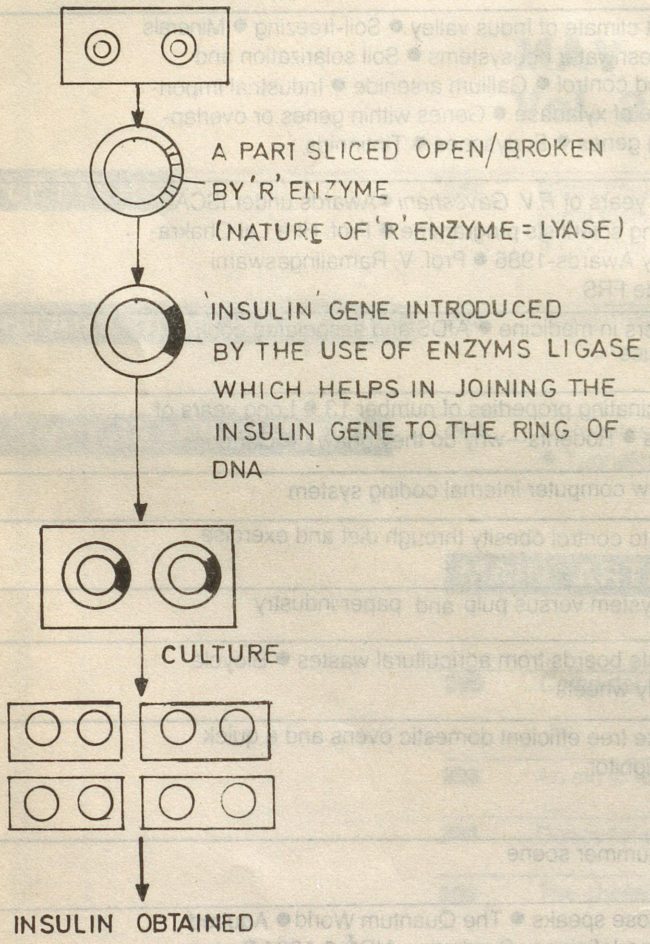

Fig. 1

In the article, nowhere it is mentioned what exactly a plasmid is; it could have been aptly phrased as a 'ring of DNA'.

Then, it is stated that 'Virus is obtained from tissues by centrifuge'. This leads the reader to a wrong path; he may think or generalise that all tissues possess virus. Further, the author has used the word 'centrifuge'. It is well known today that to obtain fractions constituting virus or virus-like organisms ultracentrifuge apparatus is used due to its very high spinning rate. The centrifuge is considered obsolete for this purpose. Ultracentrifugation would have been the right word here.

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Food and population

Sir, **Fungi: the food of the future** should not be treated as merely a fancy title of an article (*S.R.*, March 1986) advocating eating mushrooms but should be taken more seriously. The earth population doubling after every fifty years and relentlessly encroaching cultivable land would sooner or later compel us to change our dietary habits to more exotic ones.

In 1838 Malthus proposed the view that the population of earth always outgrows food supply. He predicted that in a century agricultural output would not suffice to feed human beings. He was proved wrong because in the nineteenth century scientific methods adopted in agriculture outpaced the growth of human beings.

The world population, currently galloping at the rate of 50 millions each year, would shortly pose problems of unprecedented magnitude. Even if we could imagine artificial production of foodstuff out of inorganic world via yeast culture, hydroponics and so on, the task of feeding burgeoning humanity would be stupendous, to say the least.

To give an idea how people multiply we have to recall what Charles Darwin wrote: "...if the present rate of increase (population) continued for a thousand years—not a long time in earth's history—there would still be standing room on the land surface of the earth but not room for everybody to lie down..."

S.K. Gurtu
ISSA, Metcalfe House
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Non-conventional fuels

Sir, In the article **Fuels: conventional and non-conventional** by P.D. Sunavala (*S.R.*, March 1986) there is a clear warning that petroleum will become extinct in a few decades and coal will last for a few more centuries. According to Isaac Asimov the total quantity of fossil fuels (coal, gas and oil) is expected to last till 2105 A.D. and fission power will be with us till 2285 A.D.

Besides fission process, there is fusion process as well, which is considered more efficient and is responsible for the phenomenal energy output of sun and stars. The explosion of H-bomb—in fact, an uncontrollable thermonuclear reaction—is an example of this process. In spite of the tremendous work done during the last few decades, intricacies of controlled fusion reaction have not been understood. Human beings would not have to worry about depleting energy sources once fusion power is harnessed. Because in that event, heavy hydrogen, the specific primary fuel, would be abundantly available from oceans.

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Sound speed profiles

Sir, I would like to congratulate you on publishing the excellent article **Ocean acoustic tomography** by S. Prasanna Kumar (*S.R.*, January 1986), which should be of interest to persons connected with oceanographic research. We are blessed with a coastline stretching for thousands of kilometers. From the strategic point of view and otherwise, familiarity with the littoral regions becomes absolutely imperative. There are a host of problems which remain to be solved in this sensitive and fascinating area. Articles highlighting them would therefore be most welcome.

The author has given the variation of sound speed with depth in the Bay of Bengal. In this connection I would like to further elaborate that velocity of sound in ocean is generally given as a function of temperature. The relation giving velocity in terms of these three physical variables is extremely complicated. For calculation of sound speed Del Grosso has given an equation containing 19 terms and Dovett has given a still more cumbersome equation, both amenable to computer programming. Nevertheless, there are simpler equations with an accuracy of 0.5 m/s. Finally, there are empirical relations which take into account the latitude of the place as well. The profile also depends on season, time of day and meteorological conditions.

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Black pepper

Sir, To **Black pepper—the king of spices** by B. Ganesh Bhat (*S.R.*, January 1985) I would like to add some more information for readers.

Usually pepper is grown from cuttings but it can be grown from seeds if required. Immersion in concentrated sulphuric acid ensures quicker and higher germination of seeds. Black pepper contains one more alkaloid, piperidin, but in a much smaller quantity. The pungency of black pepper is due to the resin charicine which is abundant in the mesocarp of the fruit.

The following fungi have been reported in India attacking black pepper, i.e., *Chlamydomyces palmarum, Colletotrichum necator, Colletotrichum* sp., *Fusarium* sp, *Glomerella* sp., *Pestalotia cadabae, P. piperis, Phyllosticta, Piperis-nigri, Physalospora piperina, Phytophthora palmivora, Rosellina bunodes, Sclerotium rolfsi* and *Septobasidium* sp.

The foot-rot is the common serious disease of *Piper nigrum* in Malaysia and Indonesia. The first symptom is a slight droop of the vine, followed by yellowing of leaves which drop rapidly. Rapid-die-back then occurs and the vine dies. Paul Holliday and W.P. Mowat (1957) identified the causative organism of aforesaid disease as *Phytophthora palmivora. Achatina fulica* (snail) has been found to spread foot-rot. In addition, pink disease and white root-rot caused by *Corticium salmonicolor* and *Fomes lignosus* respectively cause appreciable damage in Sarawak. *Cephaleuros mycoidea* (green algae) caused serious losses before Second World War.

Insect pests *Lophobaris serratipes, Dasynus piperis,* and *Diconocoris hewetti* cause significant damage to fruits. The root-knot nematode *Meloidogyne javanica* attacks pepper in Sarawak and *Radopholus sinilis* causes damage in Bangka (Sumatra)

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2. Holliday, P. and Mowat, W.P. (1959), A root disease of *Piper nigrum* L. in Sarawak caused by a species of *Phytophthora, Nature,* **179**: pp 543-544.
3. Samrdy, J. and Jose, P.C. (1966) *Phytophthora* wilt of pepper *(Piper nigrum), Sci cult.*,**32**: 90.

K.K. Ambasta
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Cocoanut crab

Sir, The brief article, **Cocoanut crab** by K. Venkataramanujam and A. Chamy (*S.R.*, Jan. 1986) contains many factual errors. Most of the descriptions seem obsolete and reminiscent of Darwinian era of investigation. The following sentence typifies the incorrect assessment. "The crab extracts the pulp by hammering with its heavy chela or 'arm' on the eye-hole until room is made for the small chela to enter and extract the pulp". The authors did not bother to be benefited by the several recent publications on *Birgus latro*, some of them from India itself. The drawing shown suggests that the authors have not seen a live or dead specimen carefully. The left claw as well as the walking legs on the left half of *Birgus* are larger and longer than the corresponding ones on the right half. The first pair of legs (provided with the powerful pincers) are larger than the fourth pair with small chela by about ten times. But the drawing reveals a situation that is much different from reality.

T.A. Davis
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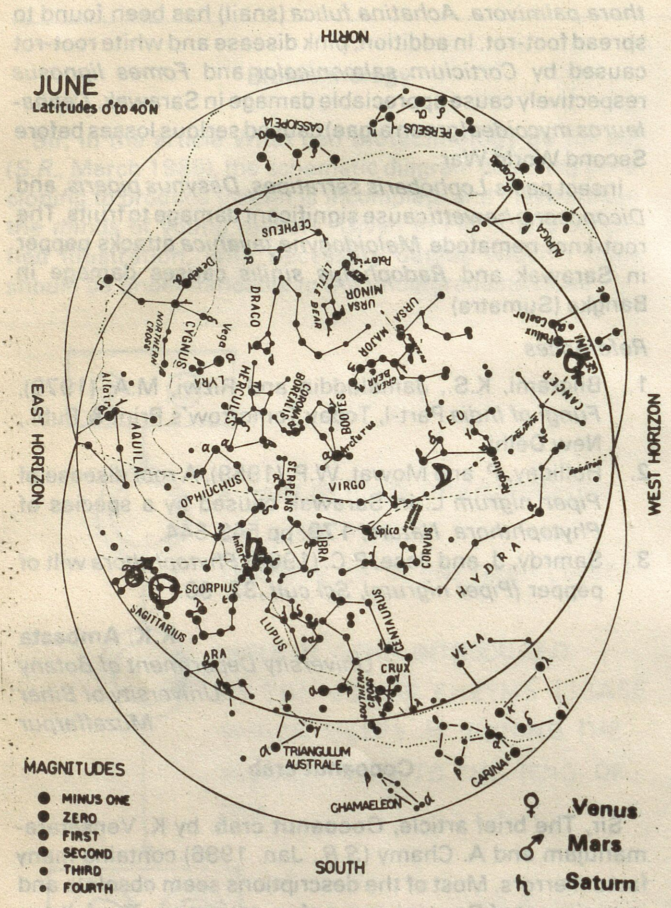
Rudolf Altevogt
Zoological Institute
Munster University
Munster, West Germany

(Continued on page 302)

STARS AND PLANETS



Planetary positions for June 1986

Date	1st		10th		20th	
Planets	R.A.	Decln.	R.A.	Decln.	R.A.	Decln.
Mercury	5h 20m	24.8N	6h 35m	25.3N	7h 40m	22.9N
Venus	6h 55m	24.6N	7h 41m	23.3N	8h 31m	20.9N
Mars	19h 40m	24.4S	19h 42m	24.9S	19h 40m	25.8S
Jupiter	23h 26m	4.9S	23h 29m	4.5S	23h 33m	4.2S
Saturn	16h 18m	19.3S	16h 16m	19.2S	16h 13m	19.1S

Adopted from figures supplied by Positional Astronomy Centre, Calcutta.

The moon

New moon occurs on 7th at 7.30 P.M. and full moon on 22nd at 9.12 A.M. I.S.T.

The moon passes about three degrees north of Mercury on 9th, three degrees north of Venus on 10th, about five degrees south of Saturn in the evening of 20th, close to Mars on 23rd and about two degrees south of Jupiter in the early hours of 28th. The lunar crescent becomes first visible after the new moon day on the evening of 8th. The moon is at apogee or farthest from the earth on 7th and at perigee or nearest to it on 21st.

The earth is at summer solstice on 21st.

The planets

Mercury *(Budha)*, 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 6° south of the star Pollux *(Punarvasu)* on 21st. It is at the greatest eastern elongation of about 25° from the sun on 26th. It moves from Taurus *(Vrisha)* to cancer *(Karkata)* through Gemini *(Mithuna)*. Its visual magnitude varies from —1.4 to +0.9.

Venus *(Sukra)*, visible in the evening sky, sets about two and a half hours after sunset during the month. It passes 5° south of the star Pollux *(Punarvasu)* on 10th. It moves from Gemini *(Mithuna)* to Cancer *(Karkata)*. Its visual magnitude is about —4.0.

Mars *(Mangala)*, visible in the morning sky, rises about two and a half hours after sunset during the first half of the month and about an hour and a half after it during the second half. It becomes retrograde on 9th. It is in Sagittarius *(Dhanus)*. Its visual magnitude varies from —1.6 to —2.4.

Jupiter *(Brihaspati)*, visible in the morning sky, rises at about midnight during the first half of the month and about an hour before it during the second half. It becomes square with the sun on 12th. It is in Aquarius *(Kumbha)*. Its visual magnitude is about —2.4.

Saturn *(Sani)*, visible in the evening sky, sets about an hour before sunrise during the first half of the month and about two hours before it during the second half. It is in Scorpio *(Vrischika)*. Its visual magnitude varies from 00 to +0.2

(Source : Director, Positional Astronomy Centre, New Alipore, Calcutta-700053)

ON THE FRONTIERS

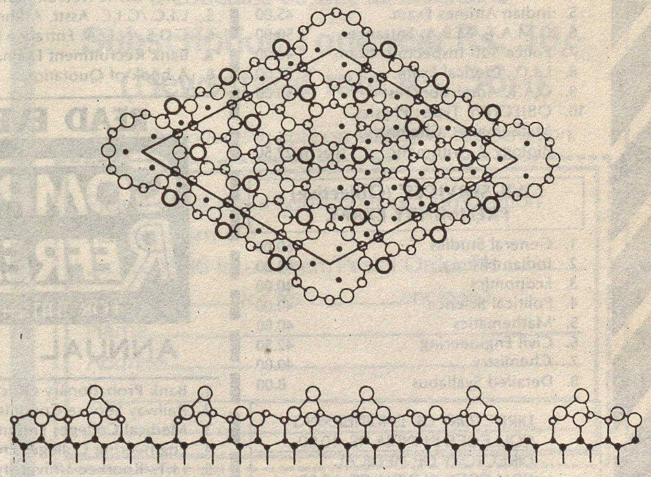
Meteorites' puzzle may throw light on their origin

SMALL bodies from space called "Meteorites" frequently fall on the surface of earth round the year. In the last two centuries of search for them, hardly 2,611 meteorites have been recovered from all corners of earth for the simple reason that terrestrial processes dissolve them, in course of time. However, in the last 17 years of search for them, on the icy continent of Antarctica, more than 7,000 meteorites have been collected for the simple reason that freezing ice preserved them intact from the date of their fall on earth. There are therefore two obvious differences between the meteorites found on Antarctica and those found elsewhere: Antarctic meteorites are very old, some even as old as earth, and secondly, on an average they are smaller in size than other meteorites. Recently, a group of scientists headed by Jane E. Dennison of Purdue University, U.S.A., has shown one more surprising and difficult-to-explain difference between these two groups of meteorites. That difference is between the trace elements found between the two groups (*Nature*, January 6, 1986).

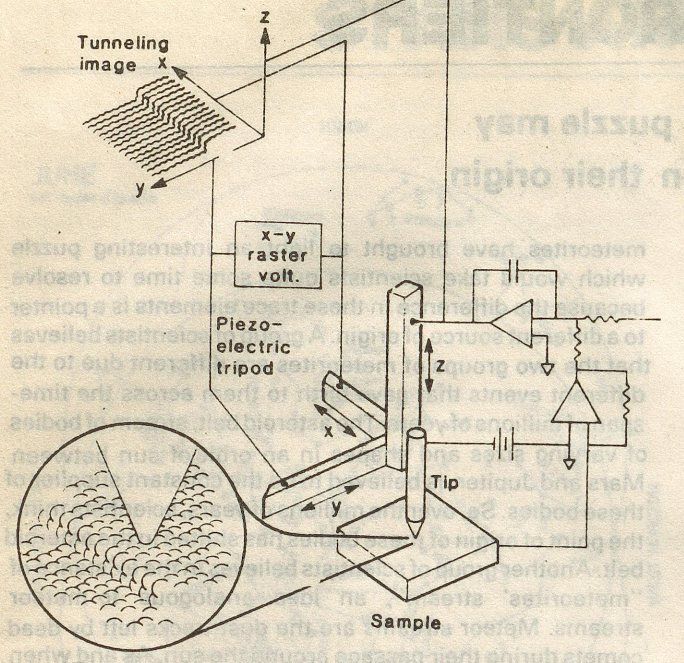
Meteorites on Antarctic continent are known for their exotic nature because it is only the pieces of Moon and Mars found there which have often been highlighted in the press. The ordinary Antarctic meteorites were never properly studied until recently. And, today, these ordinary meteorites have brought to light an interesting puzzle which would take scientists quite some time to resolve because the difference in these trace elements is a pointer to a different source of origin. A group of scientists believes that the two groups of meteorites are different due to the different events that gave birth to them across the time-span of millions of years. The asteroid belt, stream of bodies of varying sizes and shapes in an orbit of sun between Mars and Jupiter, is believed to be the constant supplier of these bodies. So, over the millions of years, scientists think, the point of origin of these bodies has shifted in the asteroid belt. Another group of scientists believes in the existence of "meteorites' stream", an idea analogous to meteor streams. Meteor streams are the dust tracks left by dead comets during their passage around the sun. As and when earth crosses them, meteor streams are observed in the sky. In a similar fashion, scientists think that there could be different streams of meteorites in space. The difference in trace elements of the meteorites that fell on earth aeons ago and those that fell in the last two centuries therefore indicates the presence of two different streams of meteorites in space which earth had crossed (or is crossing) at two different times. Several other related problems have to be resolved before scientists could arrive at any conclusive answer about the origin of meteorites.

Tunneling microscope to photograph atoms

THE desire to see a single atom or atoms has been with man from the time "atom" as an entity was established from the days of John Dalton. But more than this academic curiosity, scientists are keen to see atoms. Seeing them would tantamount to understanding their structure and their function. Understanding their function would eventually lead to their control, synthesis and modification for the good (or bad?) of the humanity. Albert V. Crewe of the University of Chicago, U.S.A., was the first scientist to show the world a photograph of atoms in the 70s. Since then, a number of efforts have been made to photograph atoms. New techniques with different principles have been developed and tried, but the one which is believed to be the most successful is the recent invention of tunneling microscope. Its inventors are G. Binning and H. Rohrer or Bell Laboratories, U.S.A. This microscope is likely to revolutionise our knowledge of world at the micro-level leading to the understanding and manipulation of materials



The arrangement of atoms in the surface layer of silicon (top and side view)



The various components of a tunneling microscope

undreamt of as yet. Tunneling microscopes are therefore currently being built in all the major laboratories of the world (*Science*, 4 April 1986).

Tunneling is derived from the domain of quantum physics; it is a phenomenon which occurs at micro-level of the material world. In simple words, for example, if electrons with some energy cannot cross a barrier, some of them would in any case overcome or tunnel through the barrier in defiance of everyday experience or classical physics. Binnig and Rohrer have employed this phenomenon to photograph atoms. The entire assembly of equipment which took the final shape is known as "Tunneling microscope". Essentially, the microscope consists of a fine, sharp metallic needle — its pointed tip as wide as the size of a single atom. It scans the material under study, a conductor or semiconductor of electricity. A minute electric potential difference is raised between the tip of the needle and the material under study. Due to tunneling effect, electrons move from the surface of the material under study to the needle, projecting in the process the image of atoms lying there. One of the biggest advantages of this microscope is that samples of interest could be readily kept under study without much formalities as required in other techniques. To date, Binnig and his co-workers have photographed atoms of silicon, germanium and gallium arsenide — the most vital for computer and electronics industry. Certainly a subject such as surface physics is likely to receive a boost from such an instrument. In the years to come, tunneling microscope is also expected to throw light on surfaces of elements, compounds, alloys and chemically treated materials. The structure of bio-molecules such as DNA and virus is also likely to be revealed by this instrument.

Dilip M. Salwi

Using optical switching devices in place of electronic transistors computers can be made to function many times faster

DHRUBA JYOTI BISWAS

COMPUTER that runs on LIGHT

EVER since the first computer was built, there has been a growing demand to increase the speed of operation of the computer. As a result, today we have super computers capable of carrying out a billion operations per second or, conversely, in just a nano-second (a billionth of a second) a single mathematical operation. The obvious question is how fast we can go in speed with these conventional electrical computers! Do we need to adopt an altogether new computer technology?

All the three basic operations of a computer, viz., arithmetical, logical and storage of information are in practice done by devices called switches that have two stable states. These two states are represented by 0 and 1 of the binary number system for arithmetical operations and true and false for logical evolution. The memory of the computer stores the results of these operations in devices that occupy one of the two states. If a computer is to operate at high speed, the time needed for switching between the output states must be short. For a computer to be capable of performing a single operation in a billionth of a second, the switching time should be as small as a nanosecond...and that is not all. In a computer there are millions of such elements with information flowing from one to the other all the time. In physical terms, information is a signal that carries any form of energy. An electrical signal can travel only about 15 centimetres in a nanosecond, and so no signal path can be longer than this if the computer has to perform at least one operation in a nanosecond. It therefore follows that this entire computer, comprising perhaps a few million circuit elements, will have to fit in a box no more than a few inches per side. With the use of the fastest transistor (switching time approximately a nanosecond) as switch this has just been possible. Attaining any higher speed than this using the electronic technology seems

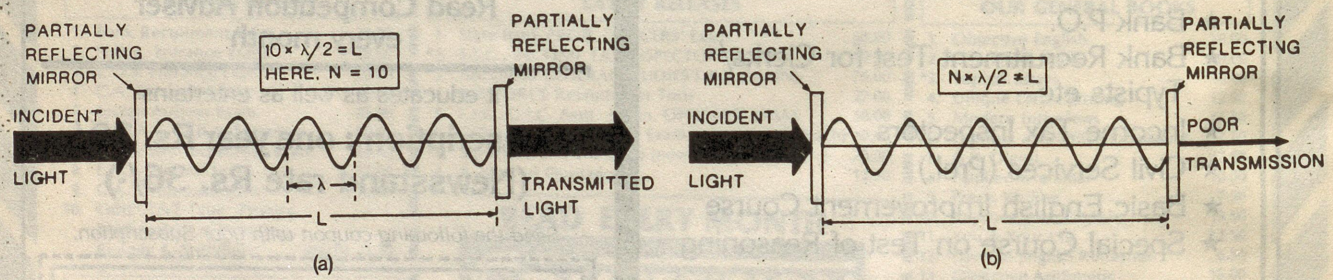


Fig. 1. The obvious way to increase the speed of operation of a computer is to replace electricity with light. The building block of such a computer, a device that can flip like a transistor between two stable states, is based on a simple instrument invented by two French physicists, Charles Fabry and Alfred Perot in 1896. The device was designed to measure the wavelengths of light but this spectacular property also possessed by it was understandably overlooked by its ninteenth-century inventors. This figure illustrates the use of a simple Fabry-Perot cavity as an ON-OFF switch for light. The transmission property of a Fabry-Perot differs significantly from either of the two mirrors it is made up off. (a) The wavelength (λ) of the incident light is such that half of it (i.e. $\lambda/2$) times an integer (N) fits exactly in the space between the mirrors and consequently the device transmits whatever light is shone on it (ON MODE OF OPERATION). The half-wavelength matching condition is satisfied here for an integer value of 10. It should be noted that in actual practice the wavelength of the light is much smaller than the mirror spacing resulting in a value of N which is much bigger than 10. (b) Any integer times the half-wavelength of the incident light falls out from the mirror separation and as a result the device hardly transmits any light (OFF MODE OF OPERATION). These points are further highlighted in Fig. 2.

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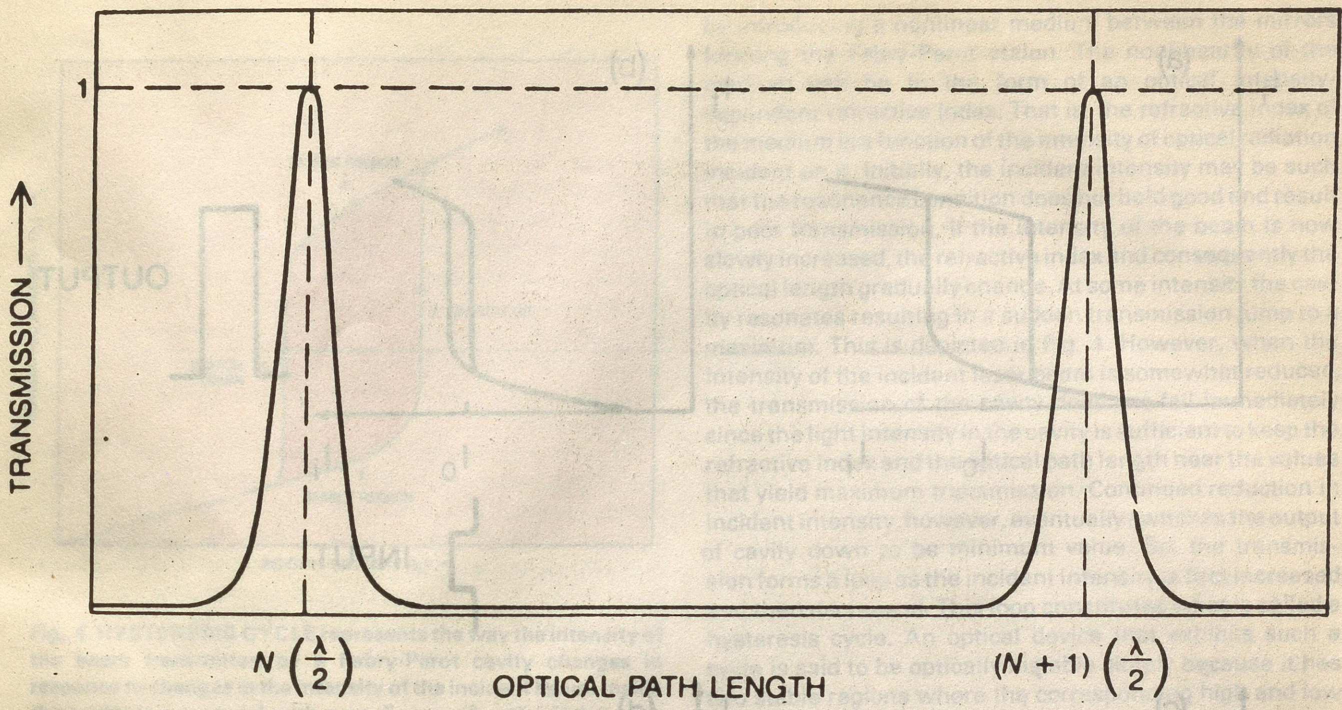

Fig. 2. The transmission of light through a Fabry-Perot cavity depends critically on its optical path length. The transmission is the ratio of the intensity of the incident beam to that of the transmitted beam; its maximum value is therefore unity. The optical path length is the physical spacing between the mirrors multiplied by the refractive index of the medium enclosed by the mirrors. This has been defined in the text. The transmission is a maximum only when the optical path length is equal to any integer multiplied bv half the wavelenth (λ) of the incident light and falls sharply to zero otherwise. It should be noted that high transmission regions correspond to the situation depicted in Fig. 1 (a) while Fig. 1 (b) is operative where transmission is poor

almost impossible. it is therefore obvious that any substantial reductions in the computational time will require adoption of a new technology.

One possibility is to replace the current of electrons with a signal of another kind to carry information through the circuit. The highest velocity a signal that carries information can have is the speed of light and so light is a suitable candidate for a new information carrier. The obvious question therefore is whether it will be possible to replace electronic circuits by coherent beams of laser light, and thereby attain the ultimate speed limit of the computer. The answer is yes, if there exists an optical analogue of transistor with switching times fast enough to match with this high signal speed. Such a switch called an optical transistor, or transphasor, was in fact operated for the first time at Bell Laboratories in the United States of America and later at Heriot-Watt University in the United Kingdom and subsequently in many other scientific institutions in recent years. The function of this switch is based on a phenomenon called optical bistability.

Optical bistability means exactly what it implies—the existence of two stable states of an optical system for a given set of input conditions. It can be described in simple terms by imagining a black box with laser light incident on one of its faces and observing what happens at the opposite face. If for a fixed intensity—defined as the flow of energy that crosses one square centimetre in one second—of laser light, the box transmits either all or very little of the light, then this box is said to be optically bistable. The box is, in fact, essentially a Fabry-Perot etalon (interferometer) containing a suitable nonlinear material.

Invented by the French physicists Charles Fabry and Alfred Perot in 1896, the Fabry-Perot etalon in its simplest form consists of two plane mirrors placed parallel to each other and separated by a distance. Each of the mirrors reflects a portion of light that falls on it and transmits the rest. Assume that the mirrors reflect 90 percent of the incident light and transmit 10 percent. Therefore, when the beam of light strikes the front mirror, 90 percent of it is reflected and 10 percent passes into the interior of the cavity. If now a second identical mirror is placed behind the first one, we would expect only one percent of the light shone on the transmitter to be transmitted. Fortunately, this is not true as otherwise this device would be of little interest as a switch for an optical computer. If the wavelength of the light is such that half of it times any integer fits exactly in the space in between the mirrors, then the Fabry-Perot etalon would ideally transmit exactly whatever light is incident on it. Mathematically, this can be written as,

$N \times \lambda/2 = L \rightarrow$ The resonance equation

where N is any integer, λ is the wavelength of the incident light and L is the optical path between the mirrors which is equal to $l\mu$; l being the actual mirror spacing and μ the refractive index of the medium enclosed by the mirrors. In all other cases, the transmission of the Fabry-Perot etalon

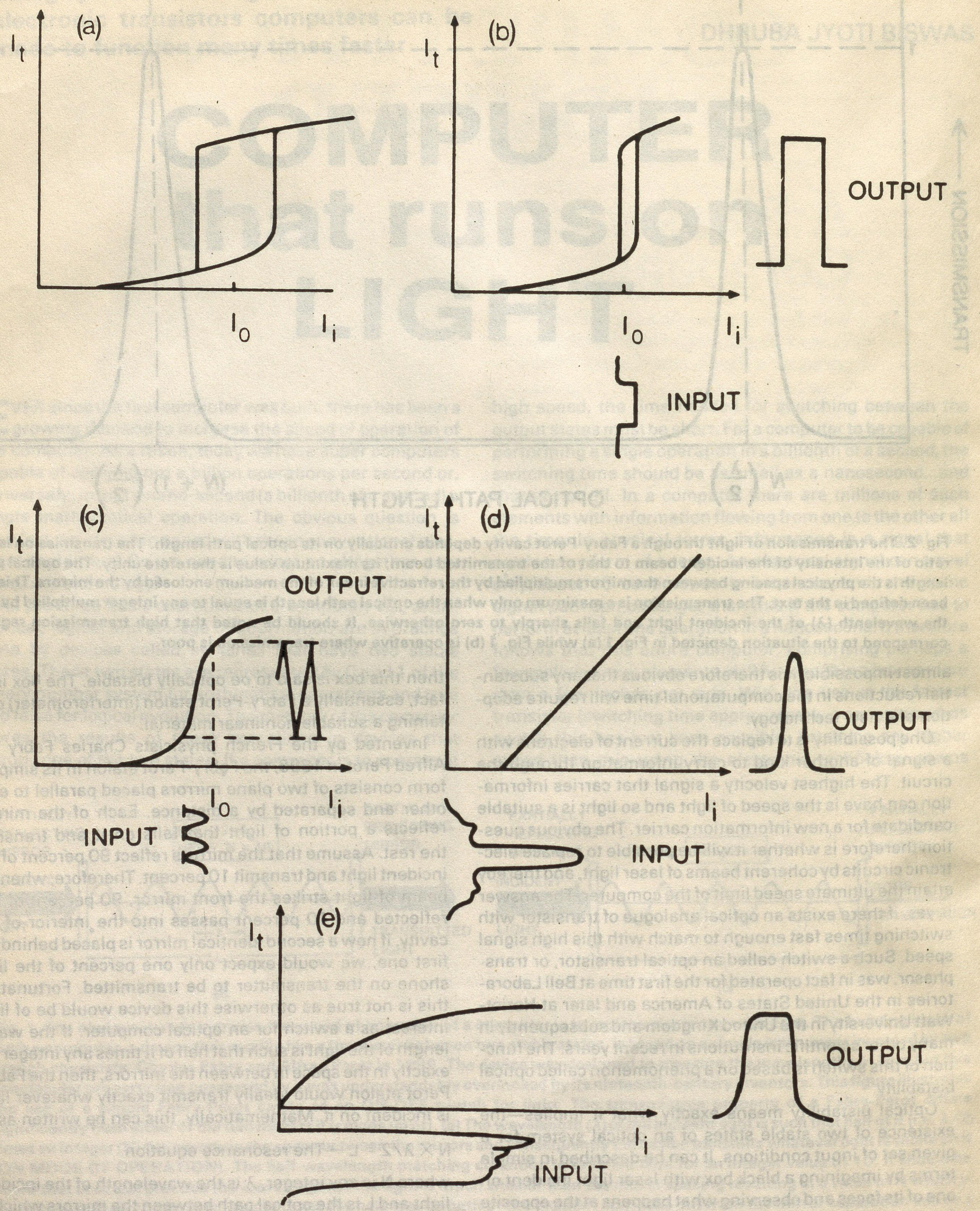

Fig. 3. Modes of operation of a bistable device : (a) bistable, (b) discriminator and pulse amplifier, (c) differential gain or optical transistor, (d) clipper and (e) power limiter. Io is the 'biasing' input intensity or 'holding power'

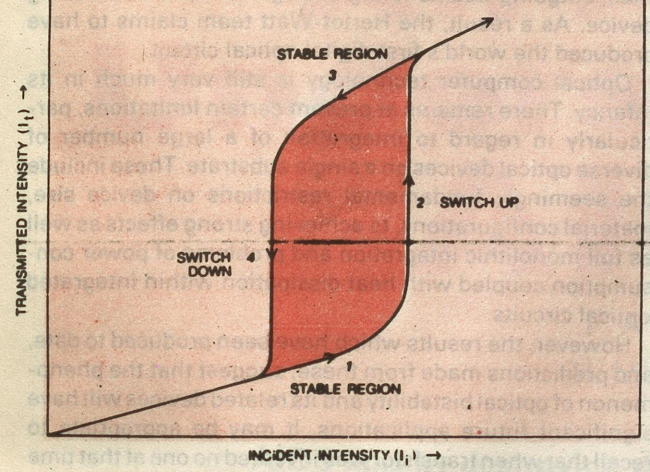

Fig. 4. HYSTERESIS CYCLE represents the way the intensity of the beam transmitted by a Fabry-Perot cavity changes in response to changes in the intensity of the incident beam. Inside the cavity is a material with a nonlinear refractive index: one that varies according to the intensity of the light in the material. Changes in the intensity of the incident beam alter the refractive index and the optical path length and hence the transmission. If the intensity of the incident beam is increased slowly, the transmitted intensity initially shows a gradual increase (1). The changes in refractive index, however, eventually brings the optical path length into resonance (i.e. $N \times \lambda/2 = L$) and consequently transmission increases rapidly (2). If the incident intensity is then reduced somewhat, transmission does not fall to the original level because there is still enough light in the cavity to clamp the optical path length near the resonance value and as a result transmission falls very slowly (3). Further reduction in the incident intensity, however, changes the refractive index to cause the transmission to sharply fall to the initial low level (4). An optical device that exhibits a hysteresis cycle is said to be optically bistable. Region 1 and 3 of the curve are the two stable regions, where transmission changes very little with changes in the intensity.

falls to a minimum (ideally zero). This has been pictorially represented in Figs. 1 and 2.

So, the output from a Fabry-Perot etalon can represent two states; one of very high and the other of very low intensity. Thus we simply have an optical equivalent of a transitor: instead of flipping between large and small electric currents the device flips between intense light beams and feeble ones. The switching between these two states is possible just by changing the length (L) of the cavity. For a certain length, the resonance equation is satisfied (maximum output) while for a different length this equation will not hold good (minimum output). The two obvious ways of achieving this—altering the distance between the mirrors or the wavelength of the light beam shining through them—are too clumsy. It would be ideal if the intensity of the beam passing out of the mirror could be flipped by varying the intensity of light shining onto it. This is possible by introducing a nonlinear medium between the mirrors forming the Fabry-Perot etalon. The nonlinearity of the medium can be in the form of an optical intensity-dependent refractive index. That is, the refractive index of the medium is a function of the intensity of optical radiation incident on it. Initially, the incident intensity may be such that the resonance condition does not hold good and result in poor transmission. If the intensity of the beam is now slowly increased, the refractive index and consequently the optical length gradually change. At some intensity the cavity resonates resulting in a sudden transmission jump to a maximum. This is depicted in Fig. 4. However, when the intensity of the incident laser beam is somewhat reduced, the transmission of the cavity does not fall immediately since the light intensity in the cavity is sufficient to keep the refractive index and the optical path length near the values that yield maximum transmission. Continued reduction in incident intensity, however, eventually switches the output of cavity down to be minimum value. So, the transmission forms a loop as the incident intensity is first increased and then decreased. This loop constitutes what is called a hysteresis cycle. An optical device that exhibits such a cycle is said to be optically bistable simply because it has two stable regions where the corresponding high and low transmitted intensities vary little with changes in the incident intensity. In addition to being hysteretic, the system also shows switching transitions usually at both edges of the bistable region. The state, the bistable system actually assumes, depends on the direction in which it traces the hysteresis curve—i.e., it has a memory (Fig.4).

The existence of optical bistability was theoretically predicted by Abraham Szoke and his collaborators at the Massachusetts Institute of Technology in 1969. It was first experimentally observed by Hyatt M. Gibbs, Samuel L. McCall and Thirumalai N.C. Venkatesan of Bell Laboratories in 1976. The optically bistable element provides a range of operation some of which are illustrated in Fig. 3. These can be obtained by changing the wave-length of light and/or the empty cavity length, and as in changing the wavelength of light and/or the empty cavity length, and as in the case of an electronic transistor, an input beam with a fixed intensity I_0 is generally necessary to play the role of the battery. In this way a 'working point' is fixed on the characteristic curve of Fig. 4 and consequently the device is biased. The first mode of operation, viz., the bistable mode, can be used as a switching element in an optical computer (Fig.3a). The device remains in the 'O' position—chosen in the low transmission branch—until an appropriate pulse is superimposed on the biasing input beam of intensity I_0; at that moment the device switches to the high transmission branch and stays in the 'I' position after the pulse has vanished. The discriminator and pulse amplifier rejects the noise and amplifies the signal (Fig. 3b). It can, in principle, be used in a repeater station of a communications network which uses optical fibres. The hysteresis cycle can shrink even further so as to become a single-valued curve with a region where the slope is greater than one (Fig.3c). The device is then in the differential gain or optical transistor mode which enables one to amplify a small input signal;

this is a potential element for an analogue circuit. The clipper provides pulses with a desired shape (Fig.3d). Finally, by means of the limiter one can cut off the noisy top of an optical signal and improve measuring accuracy (Fig. 3e).

This optical bistable switching device has three main strengths. First, these devices have switching times as short as a picosecond (a trillionth of a second). A device like this would be far superior to an analogous electronic device. Second, optical systems are compatible with optical fibre systems. If all the computations are done optically, then fibre links can be used to communicate information optically between systems. The optical fibre is therefore equivalent to copper wire in the electrical computer through which electric current flows. Owing to the higher frequency of light waves, an optical fibre link has much higher information carrying capacity than an electrical communication link. Third, there is a parallel processing capability. Parallel processors are machines in which large numbers of logic operations are performed simultaneously rather than one at a time as in standard computers. In operations suitable for parallel processing, these machines should greatly outperform standard computers. In principle, a single optical chip could contain many numbers of switching devices and laser beams could be split into sub-beams to carry out different tasks simultaneously. They would answer the prayers of computer engineers struggling to shake their machines free from one-step-at-a-time processing.

Much of the work towards computing by light is being done in both America, at Bell Laboratories and at the Optical Science Centre in the University of Arizona, and in the United Kingdom at Heriot-Watt University in Edinburgh. Notably, the group at Heriot-Watt have made optical transistors out of a variety of nonlinear materials including indium antimonide and zinc selenide crystals which do not use parallel mirrors; a rectangular crystal with polished sides does the job equally well. Better still, these transistors are 'cascadable"—as they flip; the increased intensity of their outgoing beams is big enough to flip a succeeding device. As a result, the Heriot-Watt team claims to have produced the world's first digital optical circuit.

Optical computer technology is still very much in its infancy. There remains at present certain limitations, particularly in regard to integration of a large number of diverse optical devices on a single substrate. These include the seemingly fundamental restrictions on device size, material configurations, to achieving strong effects as well as full monolithic integration and problems of power consumption coupled with heat dissipation within integrated optical circuits.

However, the results which have been produced to date, and predictions made from these, suggest that the phenomenon of optical bistability and its related devices will have significant future applications. It may be appropriate to recall that when transistor was invented no one at that time could imagine its vast number of applications. With the invention of an optical analogue of the transistor, history may once again repeat itself.

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An Aid to Understanding AIDS

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H. MUKHTAR

AIDS kills by destroying the body's immune system and at present there is no effective drug against the desease

AIDS (Acquired Immunodeficiency Syndrome) is a disease caused by a virus called Human T-cell lymphotrophic virus III (HTLV-III). The cause of this life threatening and incurable disease is apparently due to an immuno-deficiency which is somehow 'acquired' and therefore this disease is called "Acquired Immunodeficiency Syndrome" or AIDS. From a handful of cases that first appeared in a few homosexual men in 1981, AIDS has in recent years grown exponentially into a frightening world-wide epidemic. AIDS has afflicted some 15,000 people in the United States of America alone and almost half of the patients have already died. The number of AIDS patients is expected to double every year during the next five years. It has already spread to more than 40 countries. So far, there is no effective treatment for AIDS; it has a one hundred percent fatality rate, and when it develops full symptoms it is often called a death warrant. Until now AIDS has not been detected in India and before it is imported into the country, our healthcare providers must be prepared to deal with AIDS. Our hospitals and media must educate the public about prevention of AIDS. To stop the AIDS epidemic, prevention is the only way at the present time. Therefore, it is important to understand AIDS so that the victims can be treated with compassion rather than fear.

Origin of AIDS virus and its effects

It is believed that AIDS virus may be a newly evolved variant of a virus. This virus has been shown to infect a number of monkey species, including the African green monkey which originates from Zaire and neighbouring countries. AIDS has also been identified in Zaire. Some Zairians are known to kill the monkeys and eat their meat. These activities could have brought AIDS infected monkey blood into contact with human blood. From their original form, it has been suggested that AIDS virus mutated itself into a form that could infect humans. But no one knows how the virus has migrated from Africa to the United States and other countries.

In April 1984, Luc Montagnier's group at the Pasteur Institute in Paris isolated a virus. He called it "Lymphadenopathy-associated virus" or LAV, because it had been found in a patient with chronically swollen lymph glands. Within one year Robert C. Gallo of the National Institute of Health (USA) isolated a virus from an AIDS patient that he called "Human T-cell lymphtrophic virus, type three' or HTLV-III. The two viruses were later found to be virtually identical and therefore the main causative agent of AIDS is known as LAV/HTLV-III.

The primary targets of HTLV-III are T-4 cells which play a central role in maintaining the body's response to infections. The virus enters the bloodstream and integrates its genes into the DNA of some cells, primarily T-4 lymphocytes. Once the viral genes are integrated into the cell's own DNA, they can apparently remain dormant for an indefinite period without causing any ill effects. This is known as the incubation period. However, when the viral genes are activated, new virus particles convert T-4 lymphocytes into an AIDS virus factory. The exact reason why in some persons the viral genes are activated is not known. When the number of T-4 cells are severely depleted, the immune system collapses and a variety of infections appear. At this time, the victim is said to have AIDS.

Who can get AIDS?

Every person must be aware of the answer to this important question. The people most likely to infect others with the virus are those who have been infected but do not show

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Table 1. Distribution of AIDS in different groups of people in the USA as of July 1985

AIDS patients	Males	Females	Children
Homosexuals or bisexuals*	8716 (78%)	0 (0%)	0 (0%)
Intravenous drug users	1633 (15%)	418 (53%)	0 (0%)
Transfusion recipients	106 (1%)	75 (9%)	21 (14%)
Hemophiliacs	70 (1%)	4 (1%)	8 (5%)
Heterosexuals	14 (0%)	104 (13%)	0 (0%)
Children of parent with AIDS	—	—	104 (70%)
Others	593 (5%)	186 (24%)	15 (11%)
Total	11132	787	148

*Bisexuals in this context refers to a group of males who have sex with males and females

any symptoms. In USA, ninetyfive percent of the AIDS victims belong to the following groups of people.
(i) Sexually active homosexual or bisexual men with multiple partners (76 percent); (ii) Abusers of intravenous (i.v.) drug (15 percent); (iii) Persons with hemophilia or other coagulation factors (1 percent); (iv) Heterosexual contact of someone with AIDS (1 percent); (v) Persons who have had transfusions with blood or blood products (2 percent);

The remaining 5 percent of patients do not fall into any of these groups, but researchers believe that transmission would have occurred more or less in a similar way. In Table 1 the distribution of AIDS infection in different groups of people is shown

One characteristic of AIDS virus is its ability to spread. Four years after the first description of the AIDS in the USA, cases have been reported in about 40 other countries. Several countries have set up specific surveillance systems for the identification of AIDS patients. Table 2 shows the number of AIDS cases in different continents and the countries in which it has already spread. Recently, AIDS has been reported in Japan and the Soviet Union also. The spread of this disease can be related to population migration and it is believed that soon AIDS may become a worldwide epidemic.

How contagious is AIDS?

AIDS virus is probably not spread by casual contact like kissing, handshaking, living in the same household, sharing a bathroom or sitting near someone on a bus, train or plane. Ambulance drivers, police, firefighters, nurses, and doctors have not developed AIDS from caring for AIDS patients. Although the AIDS virus has been detected in saliva and tears, no cases have been documented whereby transmission through these body fluids can be linked to AIDS. The virus spreads mainly by sexual contact. Certain sexual acts facilitate the transmission of the virus. In particular, anal-receptive intercourse appears to facilitate the transmission of infected sperm into the bloodstream. The risk of getting AIDS is increased by having multiple sexual partners, either homosexual or heterosexual. Sharing of needles among those using illicit drugs also enhances AIDS infection. The occurrence of AIDS in hemophilic patients and persons receiving transfusions provides evidence for the transmission through blood. It should be remembered that not everyone exposed to the virus develops AIDS. The time between infection with the HTLV-III virus and the onset of AIDS symptoms (the incubation period) seems to range from about 5 months to 5 years and possibly longer.

Though AIDS is not transmitted through normal social contact, the fear of AIDS is spreading in general public. In USA, AIDS is being given a top priority on the covers and front pages of national and local publications and on TV shows. Although every show and story stresses the low risk of catching the disease by normal social contact, the public does not fully trust science. For most laymen, it is hard to believe that the disease is not contagious

Table 2. AIDS around the world

Continents	Affected countries	Number of cases
North America	USA, Canada	8462
South America	Brazil, Chili, Columbia, Mexico, Peru, Venezuela, Surinam, Urguay, Haiti, Grenada, St. Lucia, Trinidad	561
Australia		22
Europe	Austria, Belgium, Denmark, Finland, France, Greece, W. Germany, Italy, Norway, Netherlands, Spain, Sweden, Switzerland, United Kingdom	762
Africa	Zaire, Congo, Gabon, Mali, Cameroon, Madagascar, Chad, Uganda, Zambia, Senegal, Egypt, Togo, Burundi, Algeria, Rwande, Cape Verde, Central African Republic	111
Asia	Japan, Pakistan, Soviet Russia	Not known
	Total	9918

This list is based on information up to December 1984

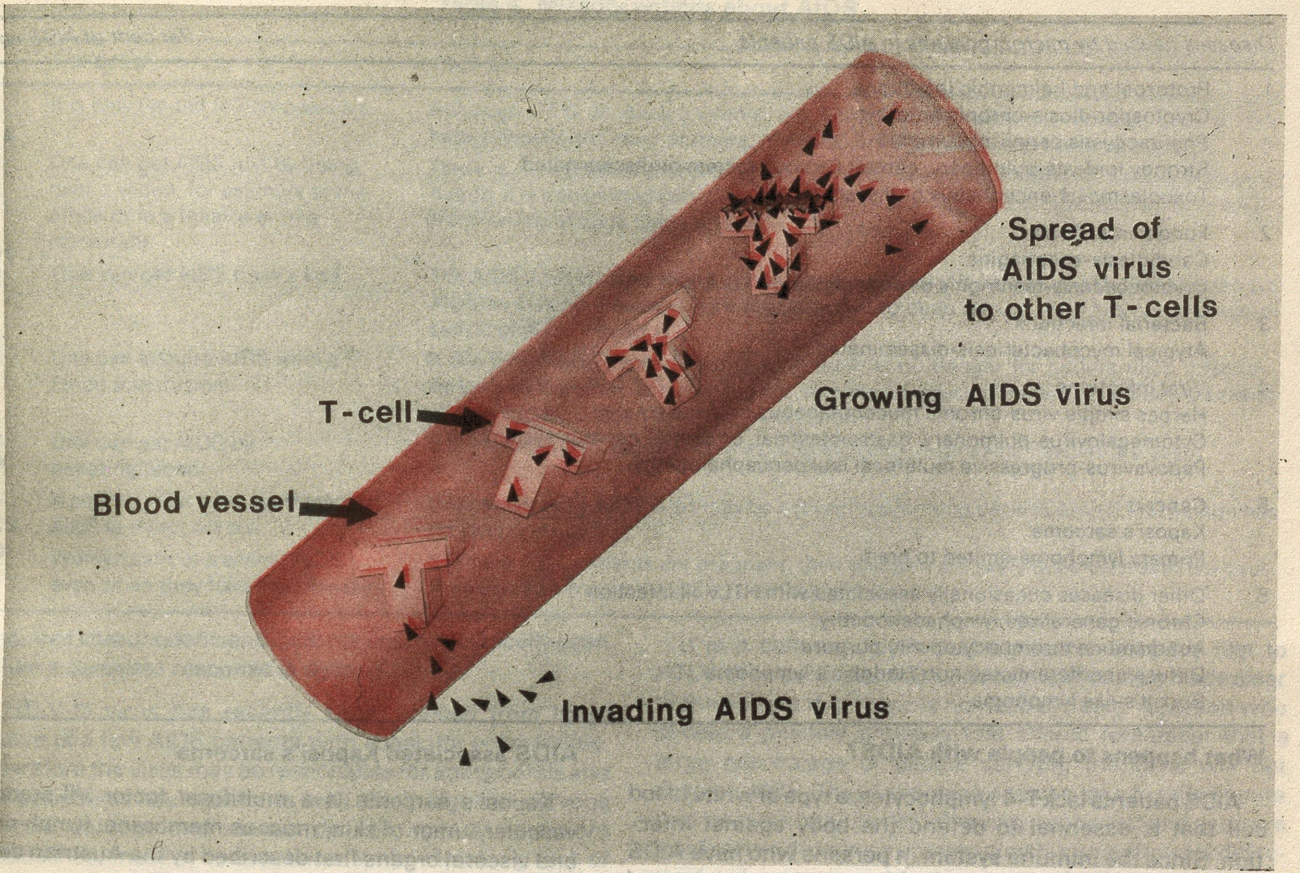

Fig. 1. How AIDS virus invades the body and multiplies

Symptoms and diagnosis

A person with AIDS may have one or more of the following:
(1) Unexpected weight loss of more than 4.5 kg in less than two months.
(2) Unexplained fever that persists for more than a week.
(3) Dry and persistent cough that is not related to smoking or a cold.
(4) Unexplained, persistent diarrhoea or blood in stool.
(5) Enlarged, swollen lymph nodes in the neck, armpit or groin.
(6) Night sweats which persist for several weeks.
(7) Persistent fatigue that is not explained by physical activity or mental depression.
(8) White patches in the mouth, and
(9) Discoloration or swelling on the skin, nose, eyelids, rectum or inside the mouth.

There are no clear cut symptoms that indicate the loss of immunity by the infection of HTLV-III virus. The diagnosis of AIDS depends mainly on the presence of opportunistic diseases. Certain clinical tests which show damages to some specific forms of white blood cells support diagnosis. Patients are questioned closely on the duration of fever malaise, diarrhoea, weight loss, respiratory symptoms (especially cough and shortness of breath), and skin lesions and about exposure to blood products. Sexual habits are also questioned in detail.

To test the presence of AIDS virus in patients and blood donors, a number of immunodiagnostic tests are currently being used. They are immunoblotting or Western blotting test, radioimmuno-precipitation with sodium dodecylsulfate polyacrylamide gel electrophoresis analysis (RIPA), cytoplasmic immunofluorescence, membrane immunofluorescence, and enzyme-linked immunosorbent assay (ELISA). The Western blotting and RIPA tests can use either concentrated extracellular virus or homogenate from infected cells as the antigen source. However, cytoplasmic immunofluorescence and membrane immunofluorescence tests need only infected cells. Recently, a kit for Western blotting analysis for the identification of AIDS virus in serum has been introduced commercially. ELISA tests use concentrated virus as the antigen source. It is important to emphasize that a positive antibody test does not indicate whether a person has the disease or not. The test only shows that individual's immune system has been exposed to the virus and it has built up antibodies to fight against them.

Table 3. HTLV-III related human diseases

Diseases caused by microorganisms in AIDS patients	Per cent of AIDS cases
1. Protozoal and helminthic infections	
Cryptosporidiosis-chronic enteritis	3.3
Pneumocystis carinii-pneumonia	41.0
Strongy loidosis-pulmonary, central nervous system or disseminated	0.1
Toxoplasmosis-encephalitis or disseminated	3.1
2. Fungal infections	
Candidiasis-esophagitis	10.2
Cryptococcosis-meningitis or disseminated	6.2
3. Bacterial infections	
Atypical mycobacteriosis-disseminated	3.9
4. Viral infections	
Herpes simple virus-chronic mucocutaneous or disseminated	3.7
Cytomegalovirus-pulmonary, gastrointestinal, or central nervous system	4.9
Papovavirus-progressive multifocal leukoencephalopathy	0.6
5. Cancers	
Kaposi's sarcoma	22.5
Primary lymphoma-limited to brain	0.5
6. Other diseases occasionally associated with HTLV-III infection	
Chronic generalized lymphadenopathy	
Autiommune thrombocytopenic purpura	
Diffuse undifferentiated non-Hodgkin's lymphoma	
Burkitt's-like lymphoma	

What happens to people with AIDS?

AIDS patients lack T-4 lymphocytes, a type of white blood cell that is essential to defend the body against infection. Since the immune system in persons who have AIDS is impaired, they are susceptible to a wide variety of illnesses. Careful monitoring of AIDS patients has revealed the nature of microorganisms that regularly infect AIDS patients. Most infections are due to microorganisms that take advantage of defects in the immune defense caused by HTLV-III virus. Table 3 describes the different types of infections caused by various micro-organisms in AIDS patients.

Infection with HTLV-III virus results in a number of immunologic abnormalities. In patients with AIDS, lymphocyte function is severely impaired. There is a lymphophenia primarily due to a decrease in the population of T-lymphocytes. Such patients have decreased skin hypersensitivity, a decreased *in vitro* lymphocyte response to stimulation by mitogens or antigens, and a decrease in the secretion of macrophage-activating products (lymphokines). In the infected population, B-cell function is also abnormal. There is spontaneous secretion of immunoglobulin by individual B-cells and polyclonal B-cell activation with an increase in serum immunoglobulins and circulating immune complexes. However, the B-cell proliferative response to T-cell independent B-cell mitogen is decreased, suggesting a primary B-cell dysfunction.

This complex array of abnormalities in cellular immune function tends to become progressively worse with time, although the rate of worsening is variable. Patients with AIDS do not recover from their immunodeficiency. They may recover from a specific infection only to develop another.

AIDS associated Kaposi's sarcoma

Kaposi's sarcoma is a multifocal factor VII-producing vascular tumor of skin, mucous membrane, lymph nodes, and visceral organs first described by the Austrian dermatologist Muritz Kaposi in 1872. An important aspect of this tumor is its epidemiology and clinical manifestations which may vary remarkably depending on the patient's country of origin and specifically whether the patient is African or non-African. Non-African or classic Kaposi's sarcoma in the USA and Europe is a rare tumor generally found in elderly men. Kaposi's sarcoma (African) occurs with great frequency in Africa than elsewhere in the world. Kaposi's sarcoma in AIDS patients seems to resemble the form of the disease seen in young African patients. The highest incidence of Kaposi's sarcoma in AIDS patients is found among homosexual men (43%), intravenous drug abusers (4%), Haitians (12%), hemophilics and patients belonging to no apparent risk group (16%).

Although AIDS-associated Kaposi's sarcoma is often an aggressive disease, death directly owing to AIDS virus does not occur in most cases. In this regard it is of interest to note that cytomegalovirus has been recovered from Kaposi's sarcoma in African cases. Kaposi's sarcoma is a radioresponsive cancer, and in patients with classic Kaposi's sarcoma limited to the skin, electron beam radiation therapy is highly successful in controlling the disease. Since AIDS-associated Kaposi's sarcoma is frequently a systemic disease with extensive visceral or nodal involvement, chemotherapy seems to be a logical mode of therapy. Chemotherapy can benefit the Kaposi's sarcoma component of AIDS in some patients but the underlying

Table 4. Misconceptions about AIDS

	The belief	*The truth*
1.	It is only limited to homosexuals:	Although 76% of AIDS patients are homosexual males, the disease also strikes heterosexuals and their partners. In Africa, AIDS primarily attacks heterosexuals.
2.	One can get AIDS just by being near a victim, for example at the office or in a theatre or in a restaurant:	There is no evidence that it is spread through sneezing, coughing, talking or shaking hands. It is transmitted only through intimate contact with the infected person in which transferring of body fluids occurs.
3.	One can get AIDS from a kiss:	The AIDS virus is rarely found in saliva and therefore it is highly unlikely that one can get AIDS by kissing. However, as a precaution step deep kissing (with heavy exchange of saliva) of AIDS victims is not recommended.
4.	One can acquire AIDS from a blood transfusion:	If the blood being transfused is safe, there is no danger for getting AIDS infection. As long as the blood samples are not screened by specific antibody test, there is a risk of getting AIDS infection by blood transfusion.
5.	One can get AIDS by donating blood:	It is impossible to acquire AIDS as long as sterile disposable needles are used.
6.	A person must have symptoms of AIDS to infect others:	Anyone carrying AIDS virus may be contagious for long periods even if that person has no symptoms.
7.	Women cannot transmit AIDS even when they have the disease:	If female AIDS patients are pregnant, their children are likely to be born with the virus. They can also transmit AIDS to their sexual partners.

acquired immunodeficiency will not improve clinically even when a complete response is seen.

HTLV-III virus has recently been isolated from brain tissue of a few AIDS patients with subacute encephalitis. Therefore the virus may be responsible for encephalitis and for peripheral neuropathy as well. Early signs of nervous system damage and mental decline include persistent headaches, inability to concentrate, slow thinking, lack of interest, withdrawal, and difficulties with language and memory. The brain damage appears to result from persistent infections of the central nervous system by the AIDS virus. In patients with brain infection, the disease seems to progress more rapidly than in those without brain infection. The presence of the virus in the nervous system suggests that it may be related to a family of virus called lentiviruses, which are known to cause degenerative nervous system disease in sheep.

Clinical evaluation of AIDS

Clinical laboratory evaluation of patients with AIDS reveals many abnormalities. They include anemia, leukopenia, lymphopenia, and thrombocytopenia singly or in various combinations. Nonspecific and mild elevations of liver function tests are common, but normal liver function, as judged by normal prothrombin times and bilirubin levels is often seen. Immunoglobulin levels, especially IgG and IgA are usually elevated. Total number of circulating T cells are often reduced. A number of abnormalities of B-cell function are common in AIDS. Serum from AIDS patients inhibits proliferation of normal T-lymphocytes. Clinical trials attempting to remove this inhibitory substance from AIDS plasma might help restore immune competence. Such trials are going on but results are not available so far. No AIDS patient has had a complete clinical reversal of the above abnormalities either spontaneously or with various treatments.

It is a common myth that a positive antibody test to HTLV-III virus means AIDS disease. It should be made clear to the patient that there is no need to panic. A person who shows a positive antibody test should remember that a large percentage of people carrying the virus will not develop AIDS. There are steps one can take to help ensure that he stays healthy. By following a good diet and getting a lot of rest and exercise one can slowly strengthen his defective immune system. Most important thing is to avoid exposure to virus again, and finally, take care not to expose others.

General preventive measures

Healthcare providers and hospitals can play an important role in preventing the spread of AIDS infection. Blood banks and other collection services should always use disposable sterilized needles so that there is no danger to a donor from a contaminated needle. Persons suspected to have AIDS should never be allowed to donate blood. Screening procedures should be conducted to eliminate the samples of blood and plasma contaminated with AIDS virus. Physicians should adhere strictly to medical indications for transfusions. Safer blood products should be supplied for use of hemophiliacs.

Women and AIDS

As of May 1985, 641 women in the USA have been diagnosed to have AIDS. Among them none are categorized as lesbian or bisexual. Women who use intravenous drugs are at higher risk for AIDS if they share needles. Over 50 percent of the women who have contracted AIDS have been i.v. drug users and approximately 11 percent of the women who have AIDS probably acquired it from sexual contact with a man who had AIDS. Since HTLV-III virus may be transmitted through semen, it can enter the body of other person who is receiving it in vagina, through normal

ICMR Task Force on AIDS

THE Indian Council of Medical Research has set up a Task Force on AIDS. The Task Force has met and reviewed the possible threat of AIDS in India. It has concluded that there is no authentic case of AIDS in India as of today, and has recommended the establishment of a surveillance machinery that would ensure investigation of high-risk groups. Two ICMR laboratories, the National Institute of Virology, Pune and Christian Medical College, Vellore, have been designated as AIDS Reference Laboratories and are undertaking sero-diagnosis of AIDS on sera from suspected patients and from high risk subjects. Clinicians in medical colleges are being alerted about the possible occurrence of AIDS among high-risk groups and are advised to send sera from suspected patients to the Reference Laboratories. The NIV Laboratory in Pune has so far investigated over 400 subjects in the High Risk category; all were found to be negative.

In India, the extent of homosexuality is not known with any degree of precision. It would be expected in situations such as jails and remand homes and slum areas. While homosexual males constitute a high-risk group, their possible contribution to the problem of AIDS in India is not clear at this time. Female prostitutes and eunuchs indulging in anal sex are likely to be a high-risk group in India and need to be investigated. In addition, the Task Force has also identified the following categories as high-risk groups — intravenous drug users, patients receiving repeated blood transfusion of blood coagulation factors, e.g., haemophiliacs, patients undergoing open-heart surgery, renal dialysis patients.

Surveillance measures

The Task Force recommended the following measures:

(1) Alerting clinicians in medical colleges to be on the look-out for AIDS in high-risk patients and to collect sera from such patients for tests for HTLV-III in AIDS Reference Laboratory.

(2) Survey of HTLV-III antibodies in high-risk groups such as Jails/remand homes, male and female prostitutes, eunuchs etc.

(3) Close watch on imported blood-products to ensure that only those batches which are certified to be free from HTLV-III are permitted to be imported to India.

(4) Dissemination of information to the general public to create awareness in the population. This may be done through pamphlets, circulars and discussions in Television Programmes.

Test for HTLV-III

The AIDS Reference Laboratories will perform the ELISA test (see *S.R.*, November 1985) for HTLV-III antibody. Sero-positive tests will be repeated for confirmation. Sera repeatedly positive by ELISA will be subject to Western Blot test. Virus isolation will be performed using neoplastic T-Cell line at the All India Institute of Medical Sciences.

The Task Force examined the tissue of surveillance of international travellers and considered it unnecessary and impractical. Routine screening of blood donors and blood transfusion specimens for AIDS was also considered not indicated at this time because of the low risk in India but the situation is under constant review.

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intercourse, in rectum through anal sex or in mouth through oral sex. The distribution of AIDS infection in women differs from country to country. In Canada and France, approximately 12 percent of AIDS victims are women, whereas in Africa nearly 40 percent of AIDS victims are women. These women are heterosexual and never used i.v. drugs or had sexual contact with bisexual men or men who use i.v. drugs.

As a result of screening procedures by blood banks, the chances of being exposed to AIDS virus by blood transfusion has been reduced drastically in western countries. Such steps must be initiated in countries like India even though there are no reported cases of AIDS infection. A number of children diagnosed with AIDS or an immune deficiency closely resembling AIDS infection are known to have been born to mothers with AIDS. HTLV-III Virus may be transmitted from infected mother to infant before, during or shortly after birth.

Infection control in hospitals

Patients with AIDS are not a danger to the general hospital community. There is no evidence of transmission of AIDS virus via casual contact or airborne spread via respiratory droplets. However, doctors and nurses who treat AIDS patients should adopt the following instructions in order to avoid infection.

1. Gloves should be worn in order to avoid contact with patient's body fluids.
2. Masks should be worn if the infected patients have coughs.
3. Needles, tissue and dressing materials should be disposed of immediately in rigid, puncture-proof containers.
4. A separate place should be selected for regular checkup and after that it should be cleansed immediately with soap and water or mild bleach solution.
5. Hospital clothes for patients should be sealed in double plastic bags until they are laundered with hot water, detergent, bleach, then machine dried at high temperature.
6. Caretakers should not touch their own mouths and bodies while providing patient care.
7. Finally, hands should be washed after attending to every patient.

Drugs under trial for treating AIDS

There are no drugs at present which can induce or restore the immune deficiency caused by HTLV-III virus. Therefore, several antiviral drugs which have shown some promise against any type of viral infection are being tested in a number of laboratories.

HPA-23: In Paris, scientists are testing a compound called HPA-23 which is an organometallic compound of tungsten and antimony. Famous movie actor Rock Hudson was treated with this drug when he was terminally ill. HTLV-III virus requires an enzyme known as reverse transcriptase in order to multiply. HPA-23 inhibits the action of the enzyme in test tube experiments and therefore there is some hope that drug may inhibit replication of the virus within the body. As yet there is no definite evidence that it helps patients with AIDS.

Suramin. This is an old drug used to treat virus-induced sleeping sickness and other parasitic disorders. This drug has been given to some AIDS patients but so far no improvement has been observed.

Ribavirin. This drug has been used to treat an African viral illness called Lassa fever. Preliminary tests are underway and the usefulness of this drug against AIDS infection is still not available.

Azidothymidine. Most of the current drugs being tested against AIDS work by inhibiting reverse transcriptase. One of the newer drugs is BW A509U, also known as azidothymidine or AZT. It is an analog of thymidine. AZT appears to inhibit multiplication of HTLV-III virus in various test tube systems as well as protects cells from being killed by the virus.

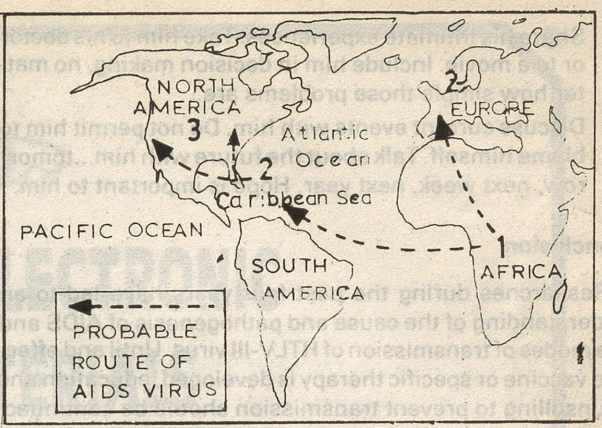
Cyclosporin A. This drug is generally given to organ-transplanted patients since it helps in preventing organ rejections. This drug is on trial in France. A few AIDS patients who were treated with this drug by oral and intravenous administrations have shown a remarkable increase in their T-lymphocyte population. It seems that cyclosporin A prevents activation of infected T-4 cells but does not inhibit production of new T-4 cells by the bone marrow and the thymus gland. In this way, the immune system strengthens itself by regenerating new T-4 cells to fight against AIDS virus. However, some scientists point out that the success with cyclosporin A is a premature claim and in the long run it could actually exacerbate the disease.

Alpha interferon. This is one of the antiviral substances naturally produced in the body in response to a viral infection. Alpha interferon seems to block the entry of the virus into healthy cells. This is currently being tested in patients and it seems to have some effect on Kaposi's sarcoma, a deadly cancer that associates with some AIDS patients.

A number of other drugs such as 9-(1, 3-dihydroxy-2-propoxymethyl) guanine (DHPG), phosphornoformate, and ansamyein are in trial in different laboratories to control HTLV-III multiplication. All antiviral drugs are potentially dangerous, particularly for a patient whose immune system is already badly damaged. The drugs can be administered to people in the early stages of AIDS. The only way to provide complete protection from HTLV-III virus infection is with a vaccine and until it is developed preventive measures are recommended to stop further infection.

Obstacles to developing effective treatment for AIDS

There are three major obstacles to developing an effective vaccine or treatment: (1) LAV/HTLV-III is a retrovirus, a



particular kind of virus unknown to infect humans until a few years ago. The genetic material of the virus is composed of double-stranded RNA which is transcribed into DNA by a viral enzyme, reverse transcriptase. The viral DNA is then integrated into human chromosomes. Once it is incorporated there, nothing can remove it—infection is lifelong and the virus reproduces at a very rapid rate. Treatment with antiviral drugs at best can succeed in suppressing multiplication of the virus, (2) Although the presence of this virus produces antibodies in the body, they never succeed in neutralizing it. The immunological reaction against infection is not generally effective. (3) Finally, the virus seems to mutate or modify its genetic structure frequently. According to researchers, the virus that causes the killer disease exists in around 100 different forms. Therefore, it is doubtful that a single effective vaccine can be developed. There is a high possibility that an antibody that works against one strain of the virus might be powerless against another mutated strain of the virus.

According to the French scientists David Klatzmann and Luc Montagnier, there are three different approaches to find out an effective therapy to AIDS. First of all they recommend extensive testing of antiviral drugs which may destroy viral particles and infected cells, or at least stop the virus from spreading. The second approach involves research in reconstituting or restoring the immune system of the body. Finally, some immunosuppressive drugs which can limit both cell stimulation and cytotoxic mechanisms should be tested based on the view that AIDS is an autoimmune disease.

Caring for AIDS victims

Advanced stages of AIDS infection is considered to be a death warrant and therefore AIDS patients, in general, may need extra social and emotional support. The following suggestions may make an AIDS patient more courageous and hopeful in his struggle against the killer disease.

1. Do not avoid him. A simple handshaking or a hug can let him know that you still care. Do not be afraid to visit him on another time.
2. Encourage him by bringing whatever he wants. Take him for a walk and spend time in talking to him. Help him to celebrate holidays.

3. Share his intimate experiences. Take him to his doctor or to a movie. Include him in decision making, no matter how simple those problems are.
4. Discuss current events with him. Do not permit him to **blame himself**. Talk about the future with him...tomorrow, next week, next year. Hope is important to him.

Conclusion

Researcnes during the past four years have led to an understanding of the cause and pathogenesis of AIDS and the modes of transmission of HTLV-III virus. Until and effective vaccine or specific therapy is developed, education and counselling to prevent transmission should be continued. Accurate research information should be made available to our healthcare providers. Community groups and health professionals should work together to utilize the tools available to prevent AIDS and care for its victims. The potential for heteroxexual transmission is very high in a country like India. We cannot underestimate the virus as others did in the past. Physicians have a central role in educating medical care personnel, members known to be at risk to AIDS, and the general behaviour based on reliable information. With our expanding dimensions of scientific knowledge we can sincerely hope for a sure and speedy progress in the treatment of AIDS infection in years to come.

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LETTERS *(Continued from page 285)*

Gamma radiation

Sir, With reference to **Gamma radiation: measurement and uses** (*S.R.*, November 1985) by J. Swarup, I would like to add a few paragraphs regarding the use of gamma irradiation in agriculture with particular reference to irradiation or mutation breeding.

Artificial transmutation of genes by subjecting plants and seeds to ionizing radiations and their utilization for production of new, improved varieties of crop plants is known as irradiation breeding.

Of all the ionizing radiations, gamma rays are most commonly used for induction of mutation in agricultural crops because they usually produce gene mutations, whereas other radiations induce mostly chromosomal mutations which disturb the whole set-up of characters in organisms. Sharbati Sonora, an amber grained wheat variety produced from the red grained Mexican variety, "Sonora-64", by gamma irradiation at I.A.R.I., New Delhi, is an example.

Methods of gamma irradiation differ depending upon the types of material and types of mutagenic treatment. Acute treatment to seeds is given inside gamma trans or gamma cell, where a tray is fixed to the aluminium tube through which radioactive cobalt (^{60}Co) source travels when lifted from the container. In this tray, seeds are subjected to the desired dosage of gamma rays. But the chronic treatment to pot-grown seedlings or plants are given in gamma garden where the plants for treatment are kept in concentric circles. The central ones receive the maximum treatment and the outer ones receive the minimum radiation from a ^{60}Co source kept in the centre.

The establishment of gamma gardens at the Bose Research Institute, Calcutta, in 1959 and at I.A.R.I., New Delhi in 1960 has opened a new vista in crop improvement through mutation breeding. At present, mutation facilities are available at the Indian Agricultural Research Institute, New Delhi; the Bose Research Institute, Calcutta; the Bhabha Atomic Research Centre, Trombay; the Tata Institute of Fundamental Research, Bombay; the National Botanical Research Institute, Lucknow, etc., where the plant material can be treated and breeding may be carried out at different places in institutions, universities, departments and farms.

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Correction

Sir, This is to draw your kind attention to page no. 184 of March 1986 issue of *S.R.* where an error has inadvertently crept in

For Spermatozoa in semen — 120 days.
Life span of red cells — 100-225 million/ml
Read Spermatozoa in semen — 100-225 million/ml.
Life span of red cells — 120 days

Aditya Tripathy
House Physician
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Global cancer research in recent years has focussed on identifying certain specific genes believed to trigger the uncontrolled growth of certain tumour cells

Genes for Cancer

RAKESH KUMAR

A tumor mass removed from a patient is a large aggregation of cancer cells, all of which are derived from a single "founder" cell. Cancer cells are characterised by many distinctive properties: altered morphology, loss of contact, inhibition, high sugar uptake, increased anaerobic glycolysis, altered surface topology and changed immunological behaviour, to name a few out of a long list. The single "founder" cancer cell was also once a normal cell with a normal function which somehow became cancerous as a result of a fundamental change. It is this change which relieves the cell of the normal constraints on cellular growth and leads to uncontrolled cell division and proliferation in response to its own imperative, rather than in response to the external stimuli, generally required for cellular growth.

Global cancer research in recent years is focussed on identifying and characterising the molecular parameters responsible for this fundamental change of the cell. Now we know that certain specific genes, cancer-genes, are responsible for fundamental change of the cell. These cancer genes, more appropriately called oncogenes (from *Onkos,* the Greek word for mass or tumor), are the real driving force behind uncontrolled growth of many cancer cells. These oncogenes, once activated, acquire the ability to produce cancer in animals and cause malignant transformation of normal cells. Oncogenes are found in all the cells of our body, except mammalian red blood cells which lack nuclei, but the vast majority of cells never become cancerous because they never get activated. In other words, our own cell contains genes with the potential to cause cancerous transformations.

The discovery

The story of oncogene dates back as early as 1911 when Francis Peyton Rous discovered a virus which causes sarcoma in chickens. This was followed by isolation of numerous cancer-causing viruses from various types of tumors. These cancer-causing viruses are know as "retroviruses" because their genetic material is not DNA but RNA which is copied into DNA by enzyme reverse transcriptase—the reverse of the direction in which genetic information commonly flows. Around mid-1970's several groups have shown the presence of a single cancer-causing gene in the viral genome.

In 1963, Marguerite Vogt and Renato-Dulbecco at California Institute of Technology, USA, transformed for the first time hamster embryo fibroblast into cancer cells by using polyoma virus in culture. These transformed cells, when inoculated into young rats, developed tumors (Fig 1A). Further research has indicated that such a transformation was induced by viral genes which were brought into the cell during the process of infection. Continuous presence of viral gene in active form is also essential to maintain the tumor phenotype, because experimental inactivation of viral genes reverts the cells to a normal state. These studies have clearly established the genetic basis of cancer. Regarding mechanism which operates in cells

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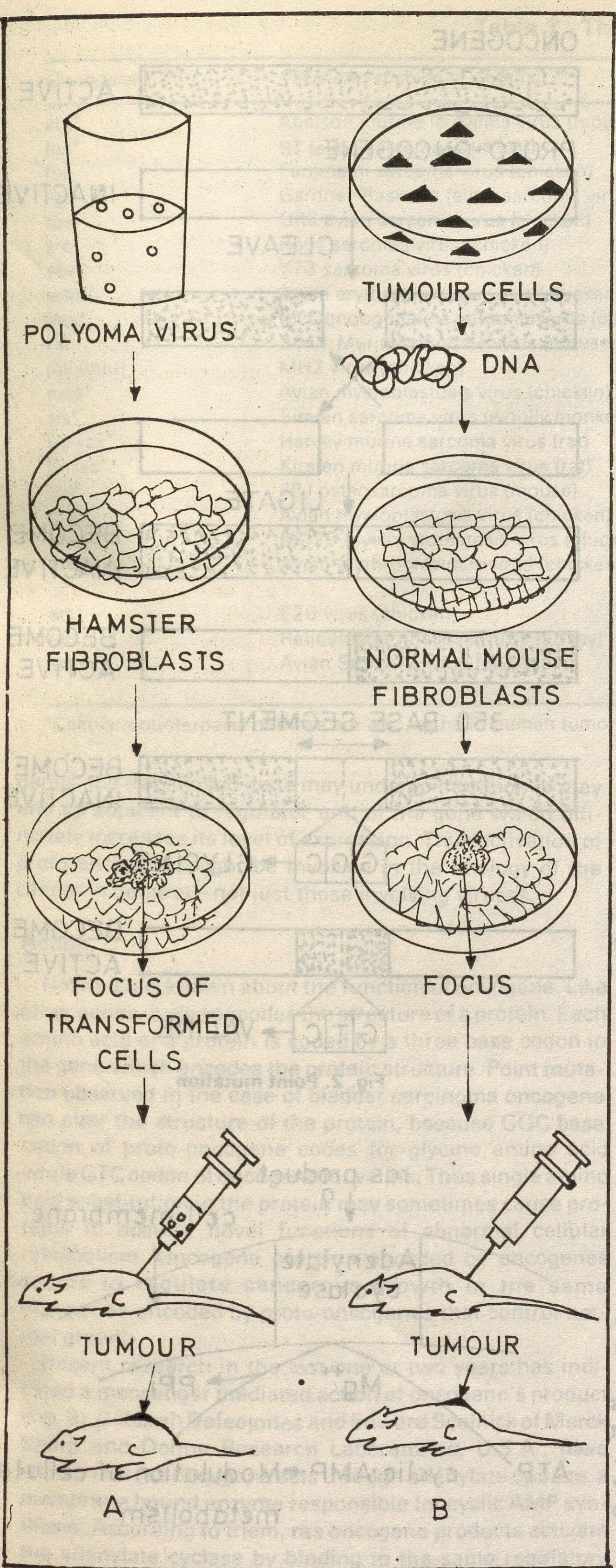

Fig. 1. (a) and (b) Genetic basis of cancer

transformed by agents other than viruses, it seems that instead of bringing genetic information into the cells, the non-viral agents (carcinogens/radiation) act by altering the existing genetic information in some way—again suggesting genetic basis of carcinogenesis.

In 1978, Chiaho Shih of Massachusetts Institute of Technology, USA, demonstrated the transmission of cancer traits from one mammalian cell to another by transfer of DNA molecules from cancer cell. Cells transformed by transfer of DNA molecules exhibit various characteristics of those tumors which are induced by tumor-virus infection and develop tumors on inoculation into mice. (Fig. 1B). Transfer of DNA molecules from normal cells had no such tumor-producing effect. These experiments indicated a difference in the DNA sequences of the tumor cells and that of normal cells, which was responsible for the cancerous behaviour of recipient cells. Similar results were obtained in case of DNA from various other types of tumors such as carcinomas of the bladder, colon and lung, fibrosarcomas, neuroblastoma and leukemias.

Having established the genetic basis of cancer, next important step was to characterise the transforming segment of DNA. The classical experiments of serial transfer of DNA through various cycles of gene transfer have shown that transforming agent resided in a single DNA segment which was not lost during repeated extraction and coprecipitation steps. With the advent of gene cloning (a technique by which a genetic segment is isolated from the cellular genome and then amplified to make many identical copies), three different groups, namely, Geoffrey M. Cooper at Dana Farber Cancer Institute, USA, and Michael Wigler's at Cold Spring Harbor Laboratory, USA, simultaneously isolated a single transforming DNA segment of potent biological activity. It was an oncogene, a cancer gene.

Origin of oncogene

Oncogene is a slightly altered version of the normal gene which is also called a proto-oncogene. Oncogenes are almost identical to each other but each functions quite different from one another. Clones of oncogenes can transform the cells, whereas those of proto-oncogenes cannot. Inclusion of proto-oncogenes in the genome indicates their possible role in normal cellular metabolism. J. Michael Bishop of San Francisco School of Medicine, University of California, USA, is of the opinion that viral oncogenes are of cellular origin. They are proto-oncogenes and their viral acquisition is belived to have occurred due to recombinational events between the genome of the infecting retrovirus and that of the host cell. These viruses in turn transform the infecting cells.

Till this day nineteen viral oncogenes have been identified and isolated (Table 1) and DNA sequences homologous to the transforming genes of certain retroviruses have been found in normal untransformed cells. DNA sequences homologous to the transforming genes of virus oncogenes have been identified in a variety of normal uninfected cells, including those of man. These cellular counterparts of viral oncogenes are known as cellular oncogenes. So far about 15 of them have been discovered in various types of human tumors. Tracing the evolution, one finds that structure of cellular oncogene is conserved throughout the evolutionary history, because it is found in species as diverse as fruit flies, fishes, mammals, including humans, and even in yeast. The close conservation of the cellular gene probably reflects its essential role in critical physiological functions—in cell differentiation or in the regulation of cell division. The question then is, what makes the gene go wrong and produce the uncontrolled cell division, seen, in cancer cells?

Activation of oncogenes

What are those factors which activate proto-oncogenes to become oncogenic and produce uncontrolled cell division and abnormal differentiation patterns seen in cancer cells? Some of the possible answers are increased production of gene product, production at wrong time, or production of a defective product in the life of the cell, which in turn makes cell cancerous. Large amounts of viral gene products have been shown to be made in infected cells. Broadly, there are three different molecular mechanisms of activation;

(i) Point mutation. Application of genetic engineering has made it possible to narrow down the region of interest from the whole gene to a relatively small fragment. In the case of human bladder carcinoma gene, transforming activity is shown to be restricted to a segment of 350 nucleotides only (Fig. 2). Sequence analysis by Ravi Dhar of National Cancer Institute, USA, suggests that only one base, a guanine in the proto-oncogene, is replaced by a thymine base in the oncogene of bladder carcinoma gene. Thus a single nucleotide, a "point mutation", in a 5000 nucleotide of normal human gene could convert it into an oncogene, Mutation of a proto-oncogene may be a critical event in the initiation of many cancers.

(ii) Chromosomal rearrangement. L.C. Grace, Shen-Ong and Michal D. Cole of St. Louis University Medical Center, USA, discovered chromosomal rearrangement as one of the possible mechanisms of proto-oncogene activation in some types of cancer; and

(iii) Amplification. In some cancer cells, there are many extra copies of a particular proto-oncogene instead of the normal two copies characteristic of most cellular genes. This oncogene amplification and in turn increased oncogene expression may also play an important role in the development of cancer by excess production of gene product. There are some intriguing clues that indicate the possibility that oncogene products may either be growth factors that stimulate cell division or may be other molecules needed for growth factor activity. The sis gene appears to code for one of the two protein chains, of which platelet derived growth factor (PDGF) is composed. Continuous production of such growth stimulating agents may be one of the factors which keeps cells in a persistent state of division when they would otherwise stop dividing. Amplification of gene is possibly one of the initial steps by which cells become cancerous or it may at least contribute to the progression of cancer to a more malignant form.

In case of mammalian tumor gene, all these three mechanisms may be at work. In the case of retrovirus-associated

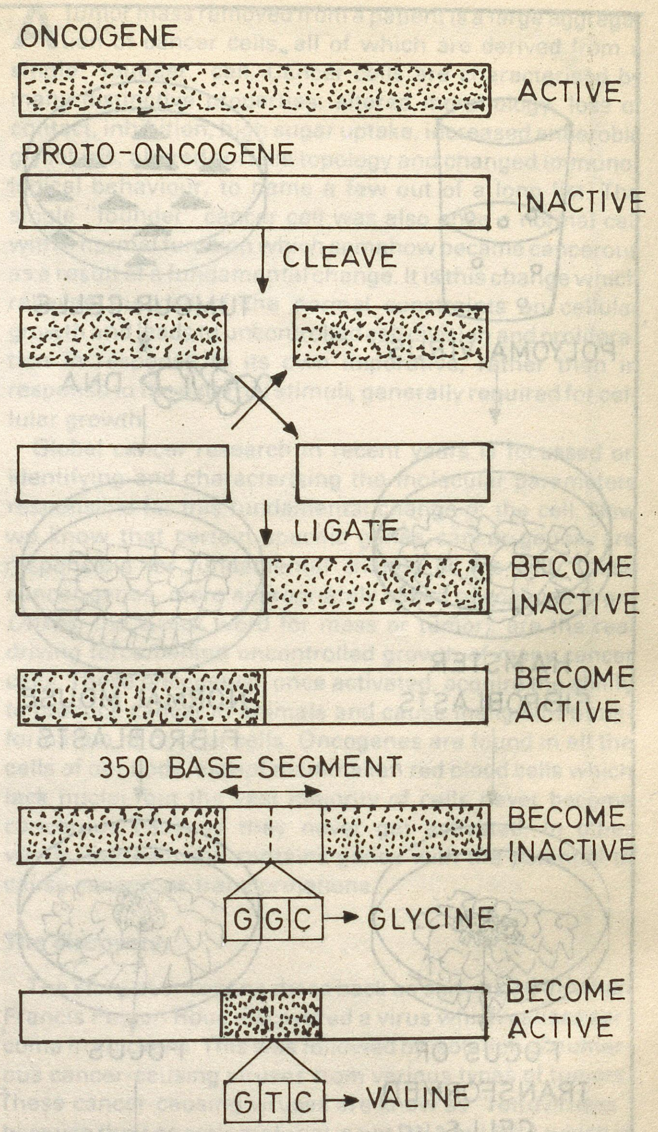

Fig. 2. Point mutation

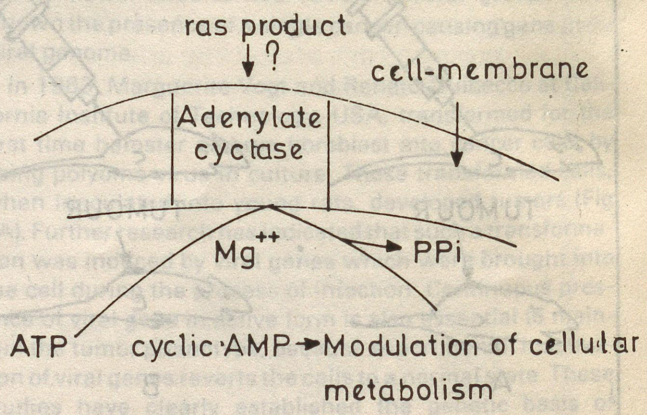

Fig. 3. Action of oncogenes

Table 1. The viral oncogenes

Oncogene	*Virus and species of origin*	*Function of products*
abl*	Abelson murine leukemia virus (mouse)	Tyrosine kinases
fes*	ST feline sarcoma virus (cat)	
fps	Funjinami sarcoma virus (chicken)	
fgr	Gardner-Rasheed feline sarcoma virus (cat)	
ros	URII avian sarcoma virus (chicken)	
src	Rous sarcoma virus (chicken)	
yes*	Y73 sarcoma virus (chicken)	
erbB*	Avian erythroblastosis virus (chicken)	Structure of a tyrosine
fms*	McDonough feline sarcoma virus (cat)	Kinase but no kinase
raf	3611 Murine sarcoma virus (mouse)	activity detected
mil (mht)	MH2 virus (chicken)	
mos*	Avian myeloblastosis virus (chicken)	
sis*	Simian sarcoma virus (woolly monkey)	Growth factor
Ha-ras*	Harvey murine sarcoma virus (rat)	Bing guanosine in (phosphate)
Ki-ras*	Kirsten murine sarcoma virus (rat)	
fos*	FBJ osteosarcoma virus (mouse)	Nuclear location-bind DNA?
myb*	Avian myeloblastosis virus (chicken)	
myc*	MC29 myelocytomatosis virus (chicken)	
erbA*	Avian erythroblastosis virus (chicken)	Cytoplasmic location-function unknown
ets	E26 virus (chicken)	
rel*	Reticuloendotheliosis virus (turkey)	
ski	Avian SKV 770 virus (chicken)	

*Cellular counterparts of these are also found in human tumors

genes, the transduced gene may undergo mutation or may end up adjacent to regulator unit of the gene which ultimately increases its level of expression. Thus activation of proto-oncogene might be involved in the etiology of the cancer in general—not just those involving viruses.

Action

Not much is known about the function of oncogene. Like other genes, it also encodes the structure of a protein. Each amino acid of a protein is coded by a three base codon in the gene which encodes the protein structure. Point mutation observed in the case of bladder carcinoma oncogene can alter the structure of the protein, because GGC base codon of proto-oncogene codes for glycine amino acid while GTC codon of oncogene for valine. Thus single amino acid substitution in the protein may sometimes cause proteins to acquire novel functions of abnormal cellular metabolism. Oncogene proteins encoded by oncogenes seems to regulate cancerous growth in the same manner as encoded by proto-oncogenes that control normal growth.

Recent research in the last one or two years has indicated a messenger mediated action of oncogene's product (Fig. 3). Doborah Defeojones and Edward Scolnick of Merck Sharp and Dohne Research Laboratories, U.S.A., have shown that ras oncogene acts through adenylate cyclase, a membrane bound enzyme responsible for cyclic AMP synthesis. According to them, ras oncogene products activate the adenylate cyclase by binding to the same regulatory component of the adenylate cyclase to which GTP also

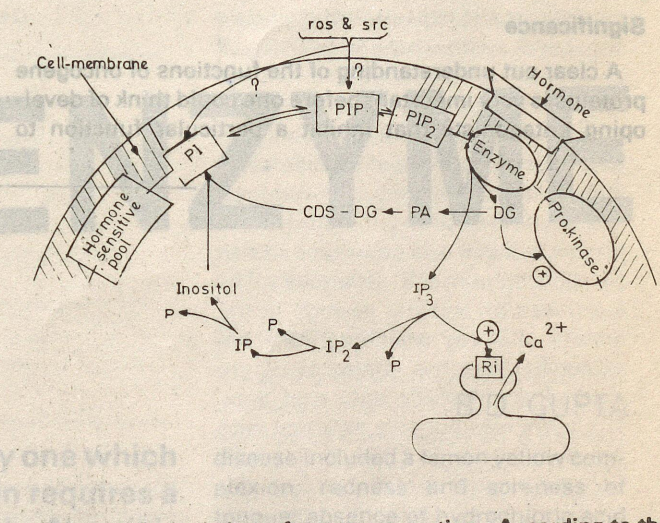

Fig. 4. Proposed view of oncogenes action—According to the new view, products of ros and src oncogenes phosphorylate phosphatidylinositol (PI) to polyphosphoinositide (PIP) and (PIP_2), which on hydrolysis form Inositol triphosphate (IP_3) and Diacylglycerol (DG). IP_3 itself causes the increase in C^{++} while DG acts independently by stimulating a Kinase. Resynthesis of PI involves conversion of IP_3 to Inositol by stepwise removal of phosphate groups. The DG is converted to phosphatidic acid (PA) and to cytosine nucleotide derivative (CDP-DG). Inositol and CDP-DG combine to produce Pi

binds and thus increases intracellular amount of cyclic AMP, which in turn brings about a number of cellular processes. Further, two groups of investigators of University of Rochester School of Medicine and Dentistry and Harvard University, USA, have proposed an entirely new mechanism of oncogene action (Fig. 4). Oncogenes act through Polyphosphoinositide system (a minor group of membrane phospholipids). The products of ras and src gene are both tyrosine kinases, enzymes that can attach phosphate group to tyrosine residue in proteins. According to the proposed new mechanism, oncogene product (enzymes) also phosphorylates phosphatidylinositol to polyphosphoinositide, which then mediates signal transmission for a wide variety of compounds including growth factors. The polyphosphoinositide system is unique in the sense that its hydrolysis (as a result of binding of ligands to its receptor and in turn activation of hydrolytic enzyme) releases two products both of which act as second messenger. One of them, inositol triphosphate, causes an increase of Ca^{++} ions from internal stores, which in turn act as third messenger and modulate further reactions in the cell. The second product diacylglycerol acts independently by stimulating a protein kinase C. Thus oncogenes may contribute to uncontrolled cell division by way of increasing the availability of the polyphosphoinositides.

These are some of the mechanisms of oncogene actions which are known today. **Nevertheless there will be many more which may or may not be dependent on each other but still contribute a lot to the process of cancerous behaviour.**

Significance

A clear cut understanding of the functions of oncogene proteins is very important before one could think of developing antagonists that inhibit a particular function to develop a cancer therapy. In the recent years, evidences have begun to accumulate that till in favour of a multistep independently controlled process in the tumor formation. Now, it is known that in most human malignancies, the presence of two or more oncogenes has been shown. The creation of an oncogene fulfills only one basic requirement for making the cell cancerous. A number of other necessary steps are required for cancerous transformation. These steps may or may not be inter-dependent. Scientists all over the world are hopeful of solving the problem of oncogene structure, structure of oncogene products, sequencing the gene and thus finding out the ultimate functions of these oncogenes. All these things will ultimately prove useful in manipulating the fundamental genetic changes that cause cancer in human body.

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THE CHEMISTRY OF COENZYME B_{12}

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B_{12} is the largest of all vitamins and the only one which contains a metal ion, cobalt, in it. This vitamin requires a special mechanism for absorption into the body. Now it is known that B_{12} is one of the family of correnoids — compounds containing a corrin nucleus

NATURE transforms one chemical species into another by chemical reactions. These reactions in human body occur in the presence of some specific compounds called catalysts. Vitamins serve as catalysts and are required by all animals and human beings. Food constitutes one of the major sources of vitamins. B_{12} is one such vitamin whose biochemistry is very fascinating. It is the largest of all vitamins and is the only vitamin which contains in it a metal ion, cobalt. It is apparently the only vitamin which requires a special mechanism for absorption into the body from the gut.

There are fewer molecules of vitamin B_{12} in a man than there are red blood cells. An adult human body contains 2mg- 5mg of vitamin B_{12} of which one mg is in the liver alone. Vitamin B_{12} deficiency leads to a variety of diseases which can now be cured easily by administering adequate amounts of vitamin B_{12}. It catalyses a number of unusual reactions of which some are still without analogy in organic chemistry. The past few decades have recorded a very significant progress in vitamin B_{12} chemistry.

The study began in 1821 with a mysterious disease now known as pernicious anaemia, caused by vitamin B_{12} deficiency. It took almost 100 years to gain knowledge into signs of the disease and methods of diagnosis. The disease was primarily recognised by diminution in the number of red blood cells, many of which lacked their normal disc-like appearance, and some of the cells were much longer than usual. Further symptoms of the disease included a lemon yellow complexion, redness and soreness of tongue, absence of hydrochloric acid in the stomach, and in the later stages neural degeneration associated with gradual paralysis of limbs. There was however no treatment of the disease which remained incurable and was usually fatal. Following a lead from W. Whipple in California (1925), physicians W.P. Murphy and G.R. Minot in Boston, Massachusetts (1926) reported a remarkable improvement in patients fed on a diet of raw liver. This clue started the search for the liver factor which lasted for about two decades. Whipple, Murphy and Minot were awarded the Nobel prize in physiology and medicine in 1934 for their discoveries concerning liver therapy against anaemias. The first phase of research in vitamin B_{12} was to isolate the factor which was present in liver in a concentration of only 1 ppm. Tons of liver were processed by various researchers. The real breakthrough was made when Karl Folkers and his group at Merck Laboratories in the United States (1948) and Lester Smith of Glaxo Laboratories in England (1948) independently announced the isolation and characterisation of red crystalline material which they named as vitamin B_{12}. It was found to be extremely active against pernicious anaemia.

The second phase of research in this direction was to elucidate structure of vitamin B_{12} by chemical and physical methods and to evolve methods for large scale production of B_{12} by fermentation techniques through screening and selection of microorganisms. Many microorganisms were discovered which were capable of synthesizing vitamin B_{12}. It is unique among vitamins in this respect. Though the chemical degradation studies to elucidate structure of vitamin B_{12} could not be overlooked, X-ray studies carried out by Dorothy Hodgkins at Oxford have played a major and important role in the development of B_{12} chemistry. The work was an exciting episode in the history of X-ray crystallography because B_{12} was the largest structure studied successfully upto that time. The work was suitably awarded with the Nobel prize in 1964. It has now become evident that B_{12} is one of a family of closely related compounds called 'correnoids' in nature. (The generic name for compounds containing corrin nucleus is correnoid.) However, the question arose: Which other correnoids occurred in nature? The most important single discovery was by H.A. Barker and his associates in California (1958) who isolated the so-called 'enzyme' form of correnoid which is generally referred to as vitamin B_{12} (coenzyme), also known as adenosyl cobalamine (AdoCbl) (Fig. 1).

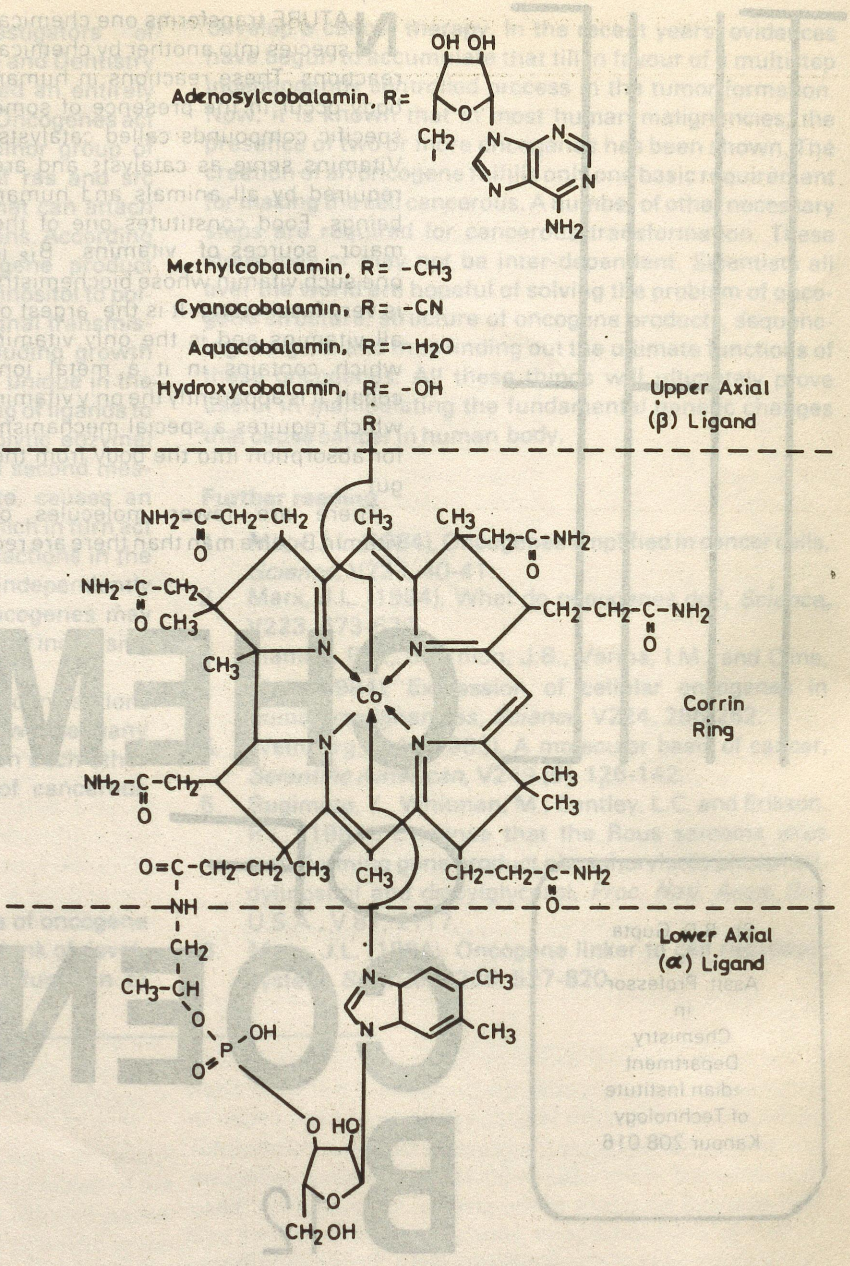
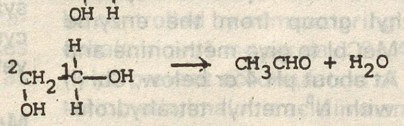
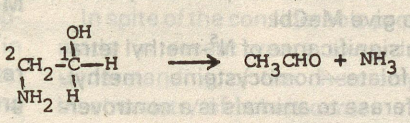
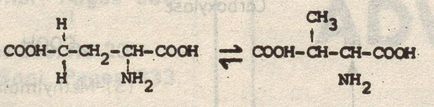
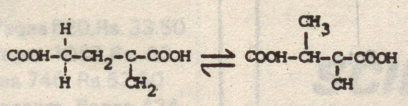
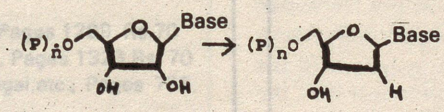


Fig. 1 Structure

It is now well established that the correnoid which is present in animal tissues is almost exclusively in the form of vitamin B_{12} coenzyme. The compound which had been isolated earlier and named vitamin B_{12} has actually resulted from the isolation procedure which converted B_{12} (coenzyme) to vitamin B_{12}. Vitamin B_{12} (coenzyme) is highly sensitive to light. If strict precautions are not taken to avoid its exposure to light, it is converted to hydroxy cobalamine (R = OH, Fig. 1) which reacts with cyanide (present in the charcoal columns originally used to isolate B_{12}) to give cyanocobalamine, that is, vitamin B_{12} (R = CN, Fig. 1). It has taken a considerable amount of research effort and many years to prove beyond doubt that various biochemical transformations in which B_{12} takes part are really mediated by the coenzyme form of B_{12} and not by B_{12} itself.

The third phase of research activity was aimed at the syntheses, properties and reactions of new organocorrenoids and their precise role in the

Table 1. Correnoid dependent enzymatic reactions

(a) Requiring MeCbl (methylcobalamine) reactions	*Reactions*
1. Synthesis of methionine by N^5 methyltetrahydropolate : homocysteine methyltransferase	See text
2. Synthesis of methane	$CH_3-B_{12} + H_2 \rightarrow CH_4 + B_{12}$ $CH_3OH + B_{12} \rightarrow CH_3-B_{12}$
3. Synthesis of acetate	$CH_3-B_{12} + CO_2 \rightarrow CH_3COOH + B_{12}$
(b) Requiring AdoCbl (Adenosylcobalamine) enzyme	*Reactions*
4. Diol dehydrase	
5. Ethanolamine ammonialyase	
6. Aminomutase utilising either i) (S)-3,6-diaminohyxanoate ii) (R)-2,6-diaminohyxanoate iii) (R)-2,5-diaminopentanoate iv) α or β-Leucine	$NH_2-CH_2)_3-CH-NH_2-CH_2-COOH$
7. Methylmalonyl-CoA mutase	See text
(c) Requiring AdoCbl (Adenosylcobalamine) enzyme	*Reactions*
8. Glutamate mutase	
9. α-Methylene glutarate mutase	
10. Ribonucleotide reductase	 $(P)_n$ = di- or triphosphate

enzymatic reactions. It was aimed to answer questions like "What reactions do correnoids catalyse in conjunction with proteins and how?" In all, a dozen enzymatic reactions have been discovered in which some form of a B_{12} compound participates as a catalyst. The total synthesis of correnoid structure with the correct number of substituents and stereochemistry was achieved in 1976. It took 11 years and a dedicated contribution of 100 chemists in a collaborative effort directed by R.W. Woodward (Harvard), the Nobel Laureate and Albert Eichenmoser (Zurich).

Another area of B_{12} chemistry which overlaps in its time span with the above work, is the coordination chemistry. Coordination chemistry here is taken to mean essentially the properties and reactions of cobalt atom and the axial ligands, and also includes the organometallic chemistry of correnoids, i.e., the chemistry of correnoids in which one of the axial ligands is an organic ligand. The study of the coordination chemistry of correnoids provoked an interest after the discovery that the co-enzyme form of B_{12} contained a Co-C bond. This led to an immediate outburst of activity amongst organic chemists in synthesizing both, the coenzyme and a wide range of other organo-correnoids. This provided the coordination chemists with a wealth of novel compounds whose properties and reactions could be investigated.

Enzymatic reaction

About a dozen enzymatic reactions are known in which some form of a B_{12} compound participates as a catalyst and there is every reason to believe that many more remain to be discovered. The known reactions are classified into two groups and are listed in Table 1.

In group (a) are reactions which involve transfer of a methyl group and require methyl cobalamine (MeCbl) (Fig. 1, R = Me). Reactions in group (b) require adenosyl cobalamine (AdoCbl) and involve a hydride transfer.

In all these enzymatic reactions, the correnoids act in association with a protein. This is an example of a pattern frequently observed in enzymatic

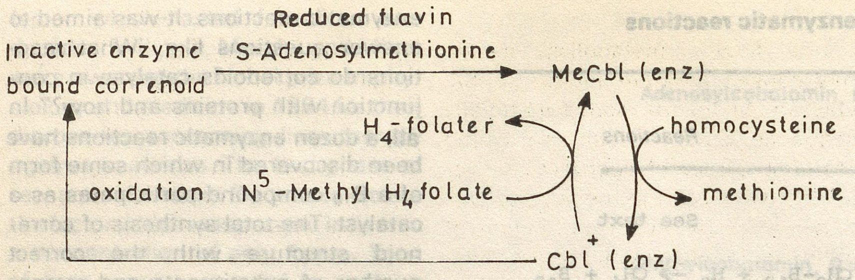


Fig. 2.1

reactions. A large number of enzymes consist of a protein (called the apo enzyme), and a smaller molecule (cofactor, coenzyme or prosthetic group) which together form an enzyme. As a general rule, it is the cofactor which contains the active sites and determines the general type of reactions the enzyme can catalyse, while the protein governs the specificity of the reactions and enhances the rate; for example, all enzymes which contain 5′ deoxyadenosyl correnoids as the cofactor appear to catalyse some types of hydride transfer reactions, but each protein confers its own specificity. Two of the reactions listed in Table 1 (number 1 and 7) are of importance in human physiology. They are now discussed in some detail.

N^5-Methyl tetrahydrofolate: Homocysteine methyl transferase

In animal tissues and in *E. coli*, methionine is synthesized from homocysteine in a cobalamine-dependent enzymatic pathway. The overall reaction is

$$N^5\text{-Methyl tetrahydrofolate} + \text{homocysteins} \rightarrow \text{Tetrahydrofolate} + \text{methionine}$$

Since methionine is an essential building block of so many proteins, conversion of the amino acid homocysteine in to methionine is important.

Methyl transfer reactions, in general, have long been studied but the studies gained importance in the past decade or so with the incidents of high concentrations of methyl mercury compounds detected in fishes found in coastal and inland waters of Japan and North America. It is now believed that formation of these highly toxic methyl mercury compounds under environmental conditions is a result of methylation of mercury by MeCbl. The biosynthesis of methionine is believed to involve the scheme (Fig. 2.1).

Enzyme bound MeCbl is formed from the non-functional cobalamine by reduced flavin and S-adenosylmethionine. Homocysteine displaces a methyl group from the enzyme bound MeCbl to give methionine and Cbl (I). At about pH 4 or below, Cbl (I) reacts with N^5-methyl tetrahydrofolate to give MeCbl.

The significance of N^5-methyl tetrahydrofolate—homocysteine methyltransferase to animals is a controversial question. Since methionine is a constituent of human diets, the role of enzymatic reactions as a producer of methioine is believed to be unimportant. However, methyltransferase is the only process for regenerating tetrahydrofolate from N^5-methyl tetrahydrofolate. This is important since it has been proposed that the clinical manifestation of pernicious anaemia may be due to a conditioned folate deficiency arising from cobalamine deficiency. Therefore, the failure to convert N^5-methyl tetrahydrofolate to tetrahydrofolate traps the former in a form which cannot accomplish all its biochemical functions. One such consequence is a retardation of DNA synthesis. Certain tumor cells, for example, possess diminished activity of N^5-methyltetrahydrofolate—homocysteine methyltransferase and cannot therefore produce sufficient methionine from homocysteines. In competition with normal cells in an environment containing homocysteine but not methionine, such cells die. Such circumstances are being exploited in a new approach to cancer chemotherapy.

In yeasts and higher plants that apparently do not contain members of B_{12} class of compounds, methionine is also synthesized. In such biological systems, the methyl transfer to homocysteine involves a different but not yet understood mechanism.

Methyl malonyl-CoA mutase

This is one of the molecular rearrangements listed in gp (b) in which a group X and a hydrogen atom exchange places, in general (Fig. 2.2).

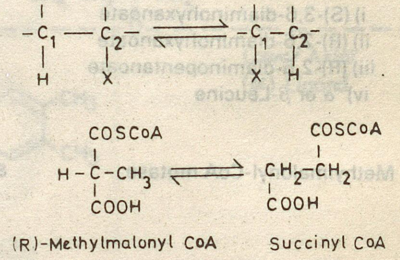


Fig. 2.2 (top) Fig. 2.3 (bottom)

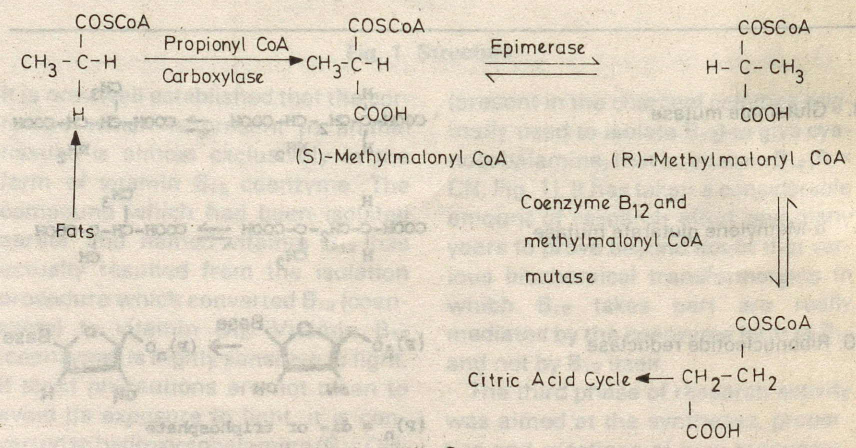


Fig. 3

out one step in a remarkable series of reactions which is vital for the maintenance of human health (Fig. 2.3).

The attention that has been devoted to this enzyme is readily explained by its key position in the metabolism of propionic acid, by its role in certain metabolic diseases and by the fact that no chemical analogy was known for this type of interconversion catalysed by it.

Methylmalonyl-CoA mutase has been found in most mammalian tissues, the highest concentration being in ruminant kidney and liver. The final diet of ruminants (the product of their rumen) consists of a considerable part of propionic acid suggesting an important role of mutase in propionate metabolism. In fact, metabolism of propionate in animals takes place through metabolic sequence as shown in Fig. 3.

Apart from the activation of propionate, propionyl CoA is formed in animal tissues by degradation of fats. To introduce propionyl CoA into the normal flow of metabolism, nature has chosen a rather circumstantial way shown in the above metabolic sequence. So any impairment of the required supply of coenzyme B_{12} or any genetic defect in the mutase protein will cause an accumulation of methylmalonyl CoA which on hydrolysis gives rise to an abnormally high concentration of very toxic methylmalonic acid. Methylmalonic aciduria, a rare genetic disease of children, is caused because proper function of methylmalonyl CoA mutase is impaired. In one form of the disease, there is an insufficient amount of the cofactor of the enzyme because of faulty biosynthesis of AdoCbl. It is responsive to B_{12} treatment and can be controlled by administering hydrocobalamine (1 mg per day). So, AdoCbl helps prevent accumulation of highly toxic methylmalonic acid in mammals.

In spite of the considerable progress made in recent years towards the understanding of the chemistry and biochemistry of cobalt-containing B_{12} group of compounds, much of the information is still awaited. However, it is now known that the free vitamin forms can function as methyl group carriers and coenzyme forms serve as hydrogen carriers. More systematic studies on the model compounds containing carbon-cobalt bond are needed before the biochemists can interpret many of their observations on the enzyme catalysed reactions.

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Past climate of Indus valley

THE Indus valley civilization, sometimes named after the site of Harappa, arose during third or late fourth millenium B.C. Apparently, it developed locally in the Indus valley out of cultures allied to contemporary groups in Afghanistan or Eastern Iran. The early Harappan phase had begun by 3500 B.C. and the full urban civilization or mature Harappan had emerged by 2600-2300 B.C. Geographically, the mature Harappan is the largest of the ancient civilizations in the Old World, extending for more than 1500 km from North to South (Fig. 1). Two large cities, Mohenjo-Daro and Harappa, unearthed in the valley, each cover several hundred hectares. This civilization came to an end in about 1900 B.C. perhaps as a result of catastrophic floods or perhaps at the hands of Aryan intruders.

The excavations at Mohenjo-Daro, Harappa, Lothal, Kalibangan, Banawali and many others have revealed eloquent clues about the varied aspects of the then civilization. Many aspects of this civilization ranging from pure archaeology, food habits to animal domestication, life and people, etc. have received attention of a large number of scholars from various fields. The climatic aspects of this civilization are discussed below.

Perusal of literature on the subject reveals three types of divergent views: (1) climate wet and more humid than the present; (2) climate drier than the present; and (3) no change in climate from the present. A host of archaeologists is of the opinion that the climate during the Indus valley civilization was wet. This has been inferred from the large size of settlements, particularly at Harappa, Mohenjo-Daro and Kalibangan; elaborate drainage system; the extensive use of burnt bricks; and the flora and fauna associated with the sites. In the fifties four reasons were cited in support of a more humid past in Sindh as follows : (a) animals of humid ecology such as buffaloes, crocodiles rhinoceros, elephants and tigers figure on the Harappan, seals; (b) considerable amount of wood needed to burn bricks; (c) elaborate drainage system; and (d) extensive agriculture.

On the other hand, in 1961, R.L. Raikes and R.H. Dyson of U.S.A. maintained that the climate during the period was dry. They attributed the success of agriculture to the frequent floods that used to occur in Sind river, which supplied fresh silt enriching the fertility of the soil. The elaborate drainage system with water tanks was created to store water for supply from scanty rainfall. They were of the opinion that the use of sun-dried bricks at the Harappan sites would be most unsuitable for a region with heavy rainfall. W.A. Fairservis of U.S.A. is not in favour of the theory of recent climatic change. He points out that the ancient sites in the valley were associated with fertile soil and water. The increasing aridity perhaps resulted in drought and famine and forced the people to migrate. The late Jorwe culture faced these vagaries of climate until 700 B.C.

The charcoal of various species of trees, namely, *Cedrus deodara, Ulmus* sp. *Dalbergia latifolia* and *Zizyphus* sp., were found in Harappa excavations. *Cedrus,* undoubtedly, was transported from the hills of North. The rest indicate marshy lands, scrubby vegetation and no change in the climate of the region. The evidence for the cultivation of cotton, barley and wheat support the prevalence of a somewhat dry climate. The presence of snail *Zootecus insularis* confirms the presence of arid climate.

Pollen analytical investigations of the Harappan sites show that wet climate prevailed in the Indus valley civilization. In 1974 Vishnu Mittre of Birbal Sahni Institute of Palaeobotany, Lucknow, re-examined the high rainfall indicators among sub-fossil pollen grains, which revealed that dry arid climate prevailed in the civilization. From an independent assessment of the pollen evidence for wet

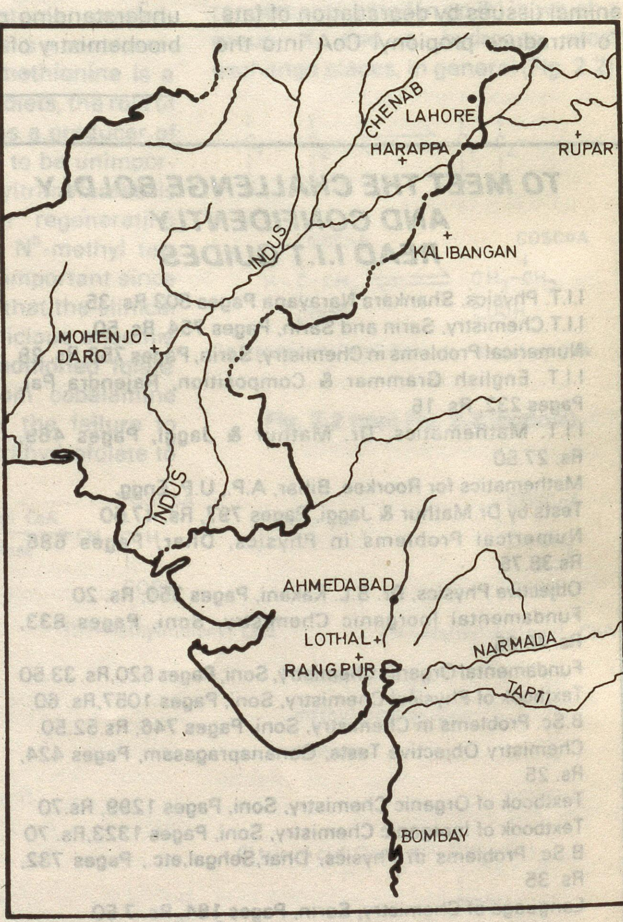

Fig. 1. The Indus Valley civilization

climate, V.M. Meherhomji of French Institute, Pondicherry, conclusion. For instance, M.S. Randhawa interpreted the charcoals recovered from the various Harappan archaeological sites reveal that species identified still occur in the vicinity of these sites, suggesting that there has been no significant change in the climate during the past 4000 years.

Literary and glyptic sources often lead to erroneous presence of Kadamb tree, in the Mathura region mentioned in *Mahabharata* as indicating a rainfall of 2500 mm in in Mahabharata as indicating a rainfall of 2500 mm in contrast with the present 600 mm. In 1962, S.K. Seth pointed out that the vernacular name Kadamb is applied both to *Anthocephalus indicus* of humid regions and *Mitragyna parsifolia* growing in water logged depressions in humid regions!

So, reviewing all the evidence hitherto put forward, it can be concluded that the Harappans lived under a somewhat drier climate with perennial water supply from rivers rather than under a wetter climate. It is left for the present researchers to settle the important issue by using modern techniques.

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Soil-freezing—the technique of ground stabilization

SOIL-freezing is an ingenious technique of freezing the ground temporarily for carrying out some specific civil engineering work. It is believed that this method was first used more than a century ago in a South Wales coalmine. There they wanted to dig a shaft though a layer of watelogged soil. Steel pipes with pointed tips were driven in to the ground in a ring round the spot where the shaft was to be excavated. Then cold brine (salt solution) was pumped down the pipes so as to form a layer of frozen ground round each pipe. Thickness of these layers gradually increases with time and eventually these cylindrical layers of frozen each pipe. Thickness of these layers gradually increases solid ring. The shaft was then begun within this 'wall' of frozen ground by digging through the still soft and unfrozen earth at the centre.

The principle employed at the South Wales coalmine has not undergone any basic change since then. However, the technique of freezing has been vastly refined. It has been observed that strength of the frozen soil rises rapidly as the temperature is lowered. By using supercold liquids (like, liquid nitrogen), it is now possible to stabilize the soild to a great extent by lowering the temperture to a sufficient degree. This method of soil freezing with liquid nitrogen has been used by engineers to avert crisis in many seemingly hopeless situations.

Take the Newcastle-upon-Tyne sewer shaft case, to cite just one example. A main sewer shaft was being excavated there in 1974. All went well upto a depth of six metres when suddenly a liquid layer of sand and water was encountered. Digging had to be stopped completely until the soil could be stabilized by freezing. A large number of steel pipes were sunk round the shaft and liquid nitrogen was pumped down the pipes. After the soil got stabilized by freezing, excavation was continued through the middle and retaining walls were constructed to hold water and sand out from the centre. The whole operation took about ten days and consumed four hundered tons of liquid nitrogen.

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Minerals in freshwater ecosystems

VARIOUS minerals are known to play important roles in pollution of aquatic ecosystems. Their roles were realised when man became concerned about the deterioration of limited freshwater resources available to him. This led to the intensive monitoring of these systems resulting in turn in a spate of literature on the interactions and effects of various minerals on other factors and parameters both biotic and abiotic within them. It was found that a number of elements mainly carbon (C), nitrogen (N) and phosphorus (P) besides molybdenum (Mo) and silica (Si) limit plant growth if present in concentractions well below the requirements, so called critical levels. The elements nitrogen and phosphorus were however found to be more important than others. Initially, their critical levels were found at 10μg $P_{inorganic}$/l and 300 μg $N_{inorganic}$/l (Sawyer 1947), while as later on values for phosphorus were arrived at 10-20μg P_{total}/l (Vollenweider 1968). The degrees of pollution of aquatic ecosystems vis-a-vis various P and N concentration levels are summarized in Table 1. A number of studies on these ecosystems conducted so far have confirmed and substantiated these findings and have revealed more on the synergistic and stimulatory interactions of N:P ratio at their advanced stages of eutrophication.

What makes them limiting

Nitrogen is one of the principal elemental constituents of proteins and on an average forms 1%-2% of dry matter of a cell, sometimes even upto 10% of algal cells. Besides proteins, it also occurs in a wide variety of other organic compounds like alkaloid purines, porphyrins, vitamins, etc. So to say, it is a major constituent of living cells and thus central to all ecosystems. In freshwaters, it occurs at several oxidation states in various forms like N_2 dissolved, ammonia (NH_3), nitrate (NO_3^-), nitrite (NO_2^-) and organic-N either in dissolved state or particulate form. Their stages in oxide-reduction reactions being:

$$NO_3^- \xrightarrow{2e} NO_2^- \xrightarrow{3e} N \xrightarrow{3e} NH_3 \longrightarrow \text{Organic-N}$$

These N-forms are used to various extents by different forms of plants and it is usually NO_3^- which is utilized in protein synthesis.

Table 1. P and N concentrations ($\mu g/l$) at various pollution stages of aquatic ecosystems (From Vollenweider 1968)

Trophic State	State of pollution	Extent	P-total	N-inorganic
I	Ultra-Oligotrophic	No pollution	<5	<200
II	Oligo-Mesotrophic	Little pollution	5-10	200-400
III	Meso-Eutrophic	Little polluted-polluted	10-30	300-650
IV	Eut-Polytrophic	Polluted-highly polluted	30-100	500-1500
V	Polytrophic	Highly polluted	>100	/1500

Phosphorus is also present as a structural element in the cell materials, its nucleic acids and enzymes and compounds which are vitally necessary for energy transfer systems in cell building and maintenance metabolisms. It occurs in freshwaters as soluble PO_4-P, particulate-P and organically bound-P. It is the soluble PO_4-P that is important in plant nutrition but as such is present in low concentractions and its availability or otherwise to plants determined among other factors by pH of the medium

Table 2. Average losses of nitrogen and phosphorus from watersheds to surface waters (kg /ha/yr). Values in parenthesis are the maximum observed (From Kajak 1980)

Catchment features	N	P
Forest	10 (35)	0.04-0.2 (0.9)
Meadows and pastures	10 (50)	0.05-0.17 (10.0)
Agricultural	2.6-26.7 (153)	0.06-2.9 (54.0)
Bare soils	33-185	0.56-2.9 (54.0)
Surface non-point outflow from towns	1.1-9.3	1.0-5.3

Where waters are calcium rich and alkaline, it gets precipitated as calcium phosphate, in acidic mediums however, it forms sometimes iron salts.

What are their sources?

These minerals enter aquatic ecosystems from surrounding systems through different routes and ways. Usually, they come in by way of surface inflow, the magnitude of which depends upon the characteristics of terrestrial ecosystems of the drainage basin and biotic influences and other factors working therein. Erosion, of which there are many causes, is one such important factor. It has been observed that finer particles which are rich in phosphorus are eroded preferentially. Agricultural practices followed

Table 4. Total-P loss (kg/ha/yr) from soils with varied fertilization (From OECD report 1973)

	Fertilization		
	minimum	average	minimum
Erosion	0.5	3.0	5.0
Surface and subsurface outflow			
I. Forests	0.01	0.05	0.13
II. Agriculture	0.06	0.4	0.8

and land use patterns adapted in catchments are the other causes. In some cases large quantities of these minerals entering lakes are found to be agricultural in origin (Tables 2) and 3). Besides, most of the excessive fertilizera applied end in downstream waterbodies (Table 4) depending however, on the methods of application, fertilizer applied its chemical composition and soil characteristics.

Contributions of these minerals to lakes by man are also considerable where catchments are habitated. Phosphorus

Table 3. Relative erosion at different land use (From Kajak 1980)

Land use	Relative erosion
Forest	1
Meadows	10
Agriculture	200
Areas of cut forest	500
Surface mines	2000

in sewage of man has been found to contain 95% of inorganic fraction which is available to plants directly. *Per capita* P contributions have been estimated at 0.11 to 2.04 kg/yr, while as nitrogen at 2.29 to 6.64 kg/yr, depending mostly on their living standards.

Where feedlots are also present in high numbers in catchment their mineral contributions to surface waters are also substantial.

Detergents especially those containing polyphosphates are found to be important in P-load to lakes and even found commonest major cause of cultural eutrophication of lakes in Europe (Lund, 1974).

Spring water ooze and groundwater seepage are also found to contribute these minerals substantially to water bodies bottom-fed from such sources. Nitrogen which occurs as nitrate in such waters undergoes dinitrification and assimilatory nitrate reduction in lake sediments due to the latter's reduced nature.

Phosphorus has besides been found in some cases to be added aerially through dust deposits. On the other hand, one of the main ways of N-input into these ecosystems is atmospheric precipitation which washes down a number of nitrogen compounds especially after electric discharges occur in the atmosphere. Moreover, nitrogen in these ecosystems is directly fixed biologically by various forms of bacteria and algae from atmosphere. Its quantification however, remains mostly unaccounted for in budgetary studies due to difficulties and limitations.

While inside a system

The concentration of these minerals within an aquatic ecosystem depends on a number of factors such as norphometry, physico-chemical set up, metabolism, trophic state and status of the ecosystem. Even hydrology also plays a great role. The resulting wane and wax of the minerals in relation to time is of great limnological interest Generally, it has been seen that if the concentration levels increase above the required threshold levels during the growing period with other factors also being favourable at the same time, the obvious results will be an abundant and luxuriant vegetative growth. The undesirable side effects of which include chocking of these freshwater systems resulting in deterioration of their water quality, effects on their metabolism, fish mortality, loss of recreational potential and scenic beauty, and ultimately loss of their economic value.

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Soil solarization — a new approach to weed control

TODAY, weed problem has turned into a continuing struggle for man as the pressure to maximise crop production has tremendously increased to meet the needs of fast increasing human and animal populations. The overall losses caused by weeds in India had been estimated at 27% of field crop production for irrigated as well as rainfed crops.

In India, crops are usually weeded with hand labour, consuming an inordinate amount of a farmer's time. The chemical weed control (herbicides) has not been widely accepted in Indian agriculture because of the availability of farm labour at low wages, and of only few herbicides commercially available, lack of technical training and high cost technology of herbicide usage. Moreover, herbicide use on small farms is often impractical for several reasons.

Although, the utility of herbicides for weed control cannot be questioned, their indiscriminate use is not free from problems. The regular use of these chemicals might affect the quality of produce and leave residues which might affect the health of consumers. Though biological control of weeds forms an effective alternative; it has its own limitations. It is applicable only where the weed and the crop are not clearly related. In addition, the introduced predator may prove harmful by changing its feeding habit.

There is a need for an alternative method of weed management system that: (1) would provide broad-spectrum weed control, (2) could be used before planting for several crops,(3) would reduce labour requirements. One such system known as soil solarization has come into practice in Israel several years ago and recently in the United States.

Soil solarization is a simple process of placing clear plastic mulches (primarily polyethylene plastic row covers) over moist soil for a period during the summer. Solar radiation raises temperature under the mulch to over 150°F, which kills most weed seeds. It was reported that more success in weed control is possible by placing the plastic mulches for a longer period. But failures are also known to occur if the soil does not acquire enough heat during cloudy days, if solarization period is short or there is dust layer on the plastic mulch or if the soil moisture content is too low.

By solarizing soil beds in summer, the farmer (after removing the mulch can go directly for planting without further weed management operation. Even for rainfall planted crops, the prior soil solarization treatment was known to control weeds effectively. Effective control of weeds and substantial increase in the yield of several crops was reported by following soil solarization. But, this system is expensive relatively.

Soil solarization, though not a substitute for herbicides forms an effective alternative to weed control, especially for situations where herbicide application proves difficult.

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Gallium arsenide — a new promise

A solar cell is a photovoltaic device to convert sunlight into electrical power and to deliver this power into a suitable load in an efficient manner. The most important application of solar cells in the past has been in space programmes. The advantages of solar cells lie in their ability to provide nearly permanent, uninterrupted power at no operating cost with only heat as waste product, and conversion of light directly into electricity rather than some intermediate form of energy. Till now, the most widely used solar cells have been those made from silicon, though a variety of other materials, namely, cadmium sulphide, cadmium telluride, indium phosphide, gallium phosphide and gallium arsenide are also suitable.

At present gallium arsenide solar cells are the only ones which have a high efficiency and are capable of operating at high temperatures. These characteristics are particularly desirable because they enable us to use concentrated sunlight to increase power output, minimise cell weight and reduce cost. Gallium arsenide solar cells are being considered for use in a solar power satellite and in a high temperature, near sun space science mission. The space environment in which solar cells have to operate has high temperatures and high doses of radiation, which over long periods of time degrade conventional solar cells. The advantages offered by this material over its rival silicon are as follows: (1) Electrons move six times faster than in silicon; (2) It absorbs sunlight more efficiently than silicon; (3) It can operate at much higher temperature than silicon, reducing the cooling requirements for computers and other electronic systems; (4) It emits light which silicon cannot do; (5) It has a higher resistance to radiation than silicon—essential for space satellite which are always under the influence of damaging particles such as electrons, X-rays protons, etc., coming from the sun; and (6). It uses less power than silicon and can combine the processing of both light and electronic data on a single chip.

Consider now the chemical composition of gallium arsenide. Gallium is a silver grey metallic element widely distributed in small quantities. It is a bye-product in aluminium production. It behaves as a liquid over a wide temperature range and for this reason is sometimes used in high temperature thermometers. On the other hand, arsenic is a well known poison and is a bye-product of lead or copper refining. It usually comes in three forms, namely silver-grey crystalline brittle solid, black amorphous powder, and yellow crystalline solid. The combination of these two elements, i.e., gallium and arsenic, yields the new synthetic semiconducting compound gallium arsenide, which has been put to a variety of uses in recent times.

Hardly about 0.01 percent of gallium is present in the crust of earth. The main hurdle in combining the two elements, gallium and arsenic, is that they have impurities which are difficult to eliminate. Impurities affect the electronic properties of gallium arsenide. Another difficulty in mixing of the two elements is that arsenic emits poisonous vapours at high temperatures. Japanese scientists have found that the two could be mixed in a sealed flask to minimise the spread of poisonous vapours from arsenic. This technique is however highly expensive.

Gallium arsenide is used not only in the manufacture of super-computers with vast capabilities but also in wrist-watches radio-telephones that can receive and transmit signals via orbiting satellites. It is not possible for silicon to transmit signals fast enough, but gallium arsenide can do so. In the years to come, it would be possible to have improved robots, better medical instruments, quicker processing of seismic data, better navigation systems, etc. This will however materialise only when the manufacture of gallium arsenide is standardised.

The peculiar feature that distinguishes it from silicon is that it is man-made and not something that occurs naturally in the earth's crust. It can therefore be altered to meet specific requirements by adjusting the energy band gaps.

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Industrial importance of xylanase

THE enzyme literature is becoming extensive. It comprises well over 10,000 papers per year. Although less than 50% of these publications are concerned with microbial enzymes and most of these are quickly evaluated as having no industrial interest, still a few thousand papers per year are of potential interest for industrial development of enzymes. It is also interesting to observe that only a few papers describe the processes of the highest economic importance today.

From an economical point of view, xylanase is an important enzyme produced by fungi, bacteria and actinomycetes. Examples of some of the microbes producing xylanase are *Aspergillus niger, Aspergillus fumigatus, Cryptococcus albidus, Bacillus* sp., *Irpex lacteus, Aspergillus ochraceus,* etc.

Interest in utilization of plant waste materials has also intensified study on xylanase. An example of a new application is the addition of *Aspergillus niger* xylanase to methane fermentation process where soyabean seed coat is the raw material. The fermentation process was accelerated so as to be completed in half the usual time and chemical oxygen demand of the residue was reduced to 7% of the usual level.

D-xylans are found in the hemicellulose fraction of higher plant cell walls; they consist of β-1, 4-linked D-xylopyranose chain. In some higher plants and agricultural wastes; xylan is 20%-40% of the dry weight. Therefore, such materials seem to be available as biomass and their effective utilisation by microbial xylanase is of great interest. Xylan hydrolysis by xylanase is of interest in connection with the utilization of hemicellulosic materials and especially in the manufacture of the sweetener xylose and xylitol. Xylitol is a sugar substitute of the same sweetness and caloric value as saccharose. The main nutritional use of xylitol is as a sugar substitute for diabetics and in other clinical area. It is also recommended for general use as a non-cariogenic sweetener. Xylitol has found much economic interest, because of its properties and recently because of considerations to restrict the use of saccharine for diabetics. Interest has also increased in the use of microbial xylanase for clarification of fruit juices. It is also used as a digestive aid in pharmaceutical industry. The other possibility of the use of xylanase is the production of ethanol from xylan by fermentation process. Prof. Toivola, A. *et al.*, (1984) had performed experiments on alcoholic fermentation of D -xylose by microbes. The capacity of microorganisms to ferment xylose present in wood and plant waste material might be of practical importance. He found 5.2 g/l ethanol produced by *Candida tenuis* in test medium with 2% D-xylose. The bioconversion of xylan to triglycerides (lipids) by xylan degrading yeasts should not be overlooked. This offers an attractive alternate fuel source (Ray Fall, 1984). Experiments on microbial conversion of hemicellulose (xylan) are also getting attention for production for feeding purpose. Xylose can be fermented to single cell protein, a possible animal feed material.

Xylose can be hydrogenated to xylitol or derivatized to compounds such as xylonic and trio xyglutaric acid and methylxybside, which can be used in the manufacture of finders, sequestering agents, etc. Cost of producing fuels and chemicals by fermentation routes will depend on the successful conversion of raw materials by xylanase.

Microbiologists in several laboratories are working on problems concerned with the production of xylanase, purification and its enzymatic properties. It is characteristic of pure xylanases that the hydrolysis products predominantly constitute xylobiose and higher polymers; small amounts of free xylose are formed. The degree of hydrolysis has been increased by strain improvement through stepwise mutation and gene cloning. Since economy is the greatest barrier to industrial utilisation of xylanase, mutants with improved yield are of importance. The mutant becomes highly independent of catabolic repression.

The product of the enzymatic hydrolysis of xylan is useful from industrial point of view, as in the enzymatic hydrolysis of cellulose and starch by cellulase and amylase respectively. In the case of acid hydrolysis, the excess acid must be neutralised, and the salts thereby formed may be toxic. Therefore, the use of microbial xylanase for economical production of xylose, the starting material for the sweetener xylitol, is very important.

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Genes within genes or overlapping genes

OVERLAPPING genes are attracting considerable attention in the field of genetic research nowadays. They have been found in genomes of bacteriophages, animal viruses, insertion elements, mitochondria as well as in chromosomal DNA of bacteria. A gene is usually defined as a single nucleotide sequence or a segment of

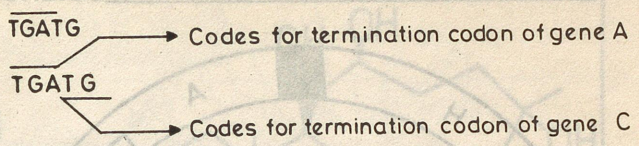

Fig. 1

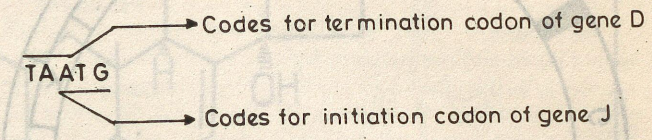

Fig. 2

DNA that codes for one polypeptide. However in case of overlapping genes a single nucleotide sequence may code for more than one polypeptide. Such an arrangement of genes was first discovered in bacteriophage ∅ × 174 and bacteriophage G4 DNA. Bacteriophage is a virus that destroys bacteria and contains only a single strand of DNA Its DNA and mRNA have a similar base sequence.

Base substitution mutations, i.e., insertion or deletion of bases in a DNA sequence, change its reading frame of the code words and as a result only a single amino acid in a protein controlled by the gene in question is affected. This was interpreted to mean that no nucleotides are members of two nighbouring codons. The codon is the "word" written in three letters of the four letter "alphabet" (represented by the four nucleotides) used for communication in nucleic acids. If there were overlaps, the repeated code letters ATCGTA could be read as ATC, TCG, CGT.... and mutation in the first C would lead to the simultaneous replacement of three amino acids. Since for years no evidence was found for such multiple changes, the genetic code was considered to be non-overlapping. An exception to this concept was first discovered in bacteriophage ∅ × 174 in 1976. The single stranded DNA genome ∅ × 174 contains nine known genes. The order of the genes on the genetic map is ABCDEJFGH and the origin of DNA replication is located within gene A. These nine genes were believed to code for nine different polypeptides. Assuming that the nine structural genes represented non-overlapping nucleotide sequences (three nucleotides per amino acid), the minimum length of DNA required to code for the nine polypeptides was shown to be 6078 nucleotides. However, its single stranded DNA genome has approximately 5374 nucleotides, which is not sufficient for the coding sequences for all nine polypeptides in non-overlapping system of genes. In order to resolve this apparent paradox, an analysis of the nucleotide sequence in the genes and of the amino acid sequences in corresponding protein products has shown that protein coding sequences of gene B is totally contained within gene A, with the two reading frames of the mRNAs they code for staggered by one nucleotide. The A gene itself extends 85 nucleotides (28 amino acids) beyond the end of the B gene and thus gene A and B are examples of overlapping. Gene C is located between genes B and D and this gene illustrates a second type of overlap. The sequence of gene C for initiation codon of the mRNA overlaps by one nucleotide

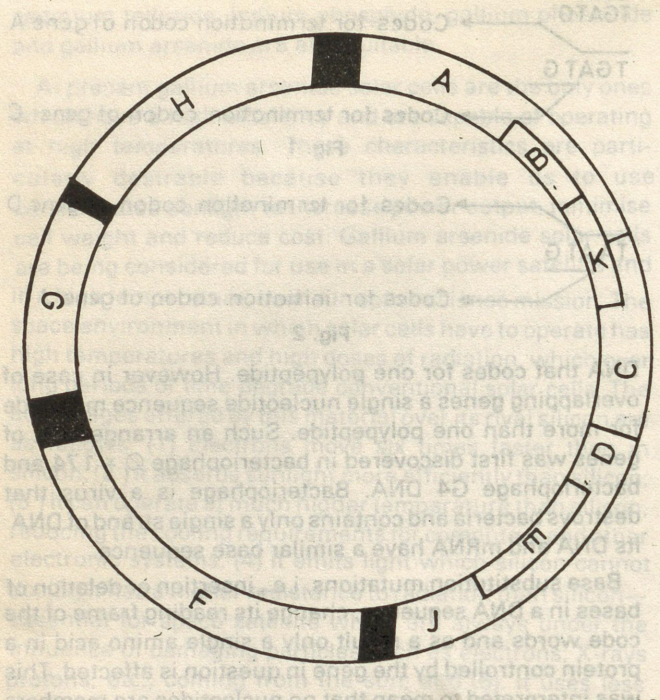

Fig. 3. The map of bacteriophage ∅ x 174, representing 10 genes (A to H), their overlaps and relative length of the non-translated regions (solid bar)

the sequence coding for the termination of codon of gene A (Fig. 1). A similar one nucleotide overlap has been observed between gene D and J also (Fig. 2).

Gene D and E also represent an example of complete overlapped within the sequences of the later completely overlapped within the sequences of the former. The genes only differ in reading frame. The products of these two genes actually have quite different functions within the cell, i.e., D codes for a protein required for production of single stranded viral DNA and E codes for lysing protein. In genetic tests they happen to be independent. Some non-translated regions are also present between gene J and F, F and G, G and H, and H and A (Fig. 3).

Sometimes the transcripts of ribosomal RNA and many other regions of eukaryotic and viral genomes may not exactly reflect the base sequences of the entire DNA of that region; that is, some DNA sequences (spacers) do not contribute to the formation of mRNA. Similarly, many nuclear and mitochondrial genes have mRNA much shorter than the genomic DNA. Several stretches are excised from the primary RNA transcripts of these genes during maturation process, but before the functional mRNA is formed. Those pieces of the gene which are not represented in the mature mRNA are called introns and those sequences which contribute to mRNA are known as exons. Such a molecular mechanism is known as RNA-RNA splicing and it may also generate transcripts of overlapping type. Such mechanism of overlapping has been observed in case of adenovirus, papova viruses and influenza virus. To elucidate the point, the example of two non-structural polypeptides NS_1 and NS_2 of influenza virus can be cited here. The influenza virus genome is composed of eight single stranded RNA segments. Each segment is transcribed into mRNA that codes for a different viral polypeptide. However, the RNA segment 8 was observed to code NS_1 as well as for a ninth polypeptide NS_2. The sequencing of the NS_2 mRNA showed that it was the direct transcript of the segment 8 while NS_1 RNA was a spliced product of it.

It is obvious nowadays that overlapping mechanism is not only to minimize the amount of DNA but it also has certain regulatory functions at translational and protein level. Regarding the evolution of overlapping mechanism, it is assumed that non-random use of codons on the complementary strands is responsible for development of open reading frames. Most of the gene overlaps are recent discoveries and many are suggested only from DNA sequences. And it is still not known how widespread this phenomenon is. However, the existence of overlapping genes demonstrates that genetic information along DNA is not arranged in well defined functional units and as a result to define the term gene is becoming tedius.

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Ecdysones—the hormonal insecticides

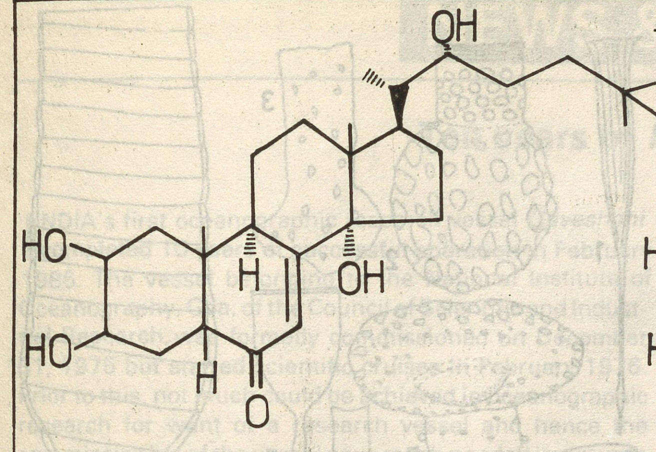
SYNTHETIC insecticides presently being used in large quantities with a considerable measure of success have proved to be a source of environmental pollution. The insecticides enter environment in alarmingly high concentrations and produce many undesirable effects on wild life, domestic animals, crops, water and birds.

A new approach to overcome the pollution problem due to insecticides is the use of 'tailor-made' hormones. They produce their insecticidal effects by dearrangement of growth processes in insects. The utility to ecdysones—steroidal compounds—as hormonal insecticides has captured world wide attention. They possess the following advantages over the conventional insecticides.

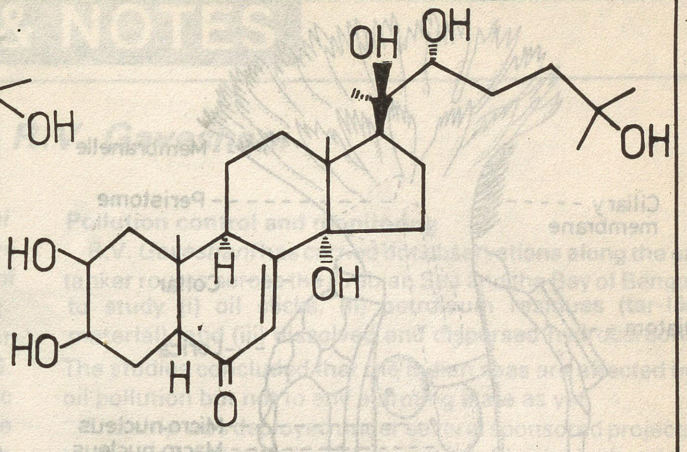
(1). Biodegradation. The supreme advantage associated with the use of hormonal insecticides is that they do not pose an environmental hazard. These compounds undergo biodegradation by micro-organism of the soil and have therefore a short persistence in the environment. From ecological considerations, they are acceptable as insecticides.

(2). Selectivity. Hormonal insecticides are more selective in action than the broad spectrum conventional insecticides, which in some cases have been implicated in detrimental side effects on non-target organisms or on the ecosystem. In fact, hormonal insecticides are of low vertebrate or mammalian toxicity.

(3). Effectiveness. Hormonal insecticides are effective even when they are present in low concentrations. They cause death to insects when applied topically at a dosage level in nonagramme range or when injected at concentrations of less than one part per million of the body weight.



(I)



(II)

(4) Active against resistant-strains. Lastly,the hormonal compounds posses a high biological activity even against conventional insecticide-resistant strains. Also, it is an added advantage that insects find it hard to evolve a resistance or insensitivity to hormone insecticides, as they happen to be one of their secretory products.

Mode of action

Insect metamorphosis results under the influence of three hormones (activation hormone, juvenile hormone and moulting hormone) released by neurosecretory cells. One of the hormones called 'ecdysone' is responsible for moulting. As a matter of fact, ecdysone generated within the insect in a normal manner helps in the growth process of insects. When applied externally they may act as powerful insecticides even in small doses. They would upset the growth of insects.

During the life cycle of an insect, ecdysone is released at a precise rate and the normal development and moulting ensues. However, if it is exposed suddenly to a large amount (relatively speaking) of ecdysone, normal course of action is bypassed, and the insect may change into an adult prematurely and die soon. Actually it involves DNA replication when it changes from one form to another. Large doses of ecdysone stimulates immediate conversion of cuticle without allowing for DNA replication. Based on this property, ecdysone acts as a hormonal insecticide.

Chemistry of ecdysone

Ecdysones have been isolated both from insects, crustaceans (1000 kg of silkworm pupea, for example, yield 250 mg of ecdysone) animals and some plants. In fact it is simpler to isolate ecdysones from plants than from insects (and crustaceans), because concentration of ecdysones is much higher in plants. In some cases, ecdysones form 0.05%—0.1% of the dry weight of the plant.

Ecdysones have been identified as polyhydroxycholestenones (examples: α-ecdysone, I: β-ecdysone, , II). Ecdysones isolated from plants have closely related structures, they differ in the number and pattern of hydroxy groups and in the nature of acyclic side chain.

Ferns (Pteridophyta) appear to be a particularly rich source of ecdysones. It is significant that ferns appear to be particularly resistant to insect attack. Because of this alone, they merit detailed investigation. In the Conifers (Gymnosperms), the Podocarpaceae and Taxaceae families are also good sources of ecdysones.

Synthetic efforts in the preparation of α-ecdysone were initiated within a year after the establishment of structure of this compound. Some ecdysones are now available commercially.

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Tintinnids (marine protozoans) as fishery indicators

THOUGH information on the marine protozoans is plentiful, detailed studies on an important and hitherto neglected group of planktonic *ciliates*, viz., 'tintinnids' (Phylum: Protozoa; Class: Ciliata; Order: Tintinnida) were almost nil in India till 1970.

Out of the 800 species of tintinnids so far known, more than 98% are confined to marine environment. They are cosmopolitan in distribution and are restricted to the surface layers as planktonic organisms The size of tintinnid species may vary from 50 μm to 500 μm in length and from

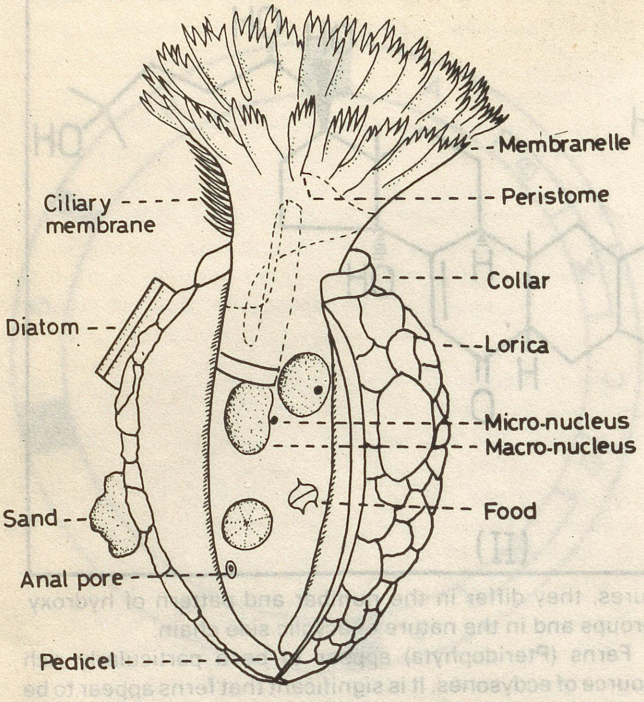

Fig. 1. Features of a tintinnid

$20 \mu m$ to $150 \mu m$ in diameter. It is worth mentioning here that the tintinnids dwell in houses or 'loricae' secreted by them. These houses may be tubular or pot like or vase shaped (Fig. 2, 1-17). The lorica may be agglomerate or clean. When it is agglomerated, it is strengthened by foreign particles like small stones, diatom frustules and tests of foraminiferans and radiolarians. The ciliated body of the tintinnids attaches to the bottom of the lorical cavity through stalk. However, in species where both the ends of the lorica are open, the attachment is on any one of the inner sides of the lorica.

Tintinnids feed on detritus, bacteria and a variety of phytoplankton such as naked flagellates, coccolithophorids, silicoflagellates and diatoms. Feeding is done through an oral opening having large, feathery membranelles of fused cilia which are retractile. The membranelles also help in locomotion.

The tintinnids are numerically important as at times they eclipse even copepods, the most important and abundant fraction of the zooplankton. By serving as an important food source to a wide variety of organisms like copepods, euphausids, cladocerans, salps, chaetognaths and fish larvae they also make a significant contribution to the biological economy of the sea particularly at lower levels of the food chain. Many of the tintinnid species of Indian waters act as biological indicators of different water types. They arrive on our coasts from Atlantic Ocean, Pacific

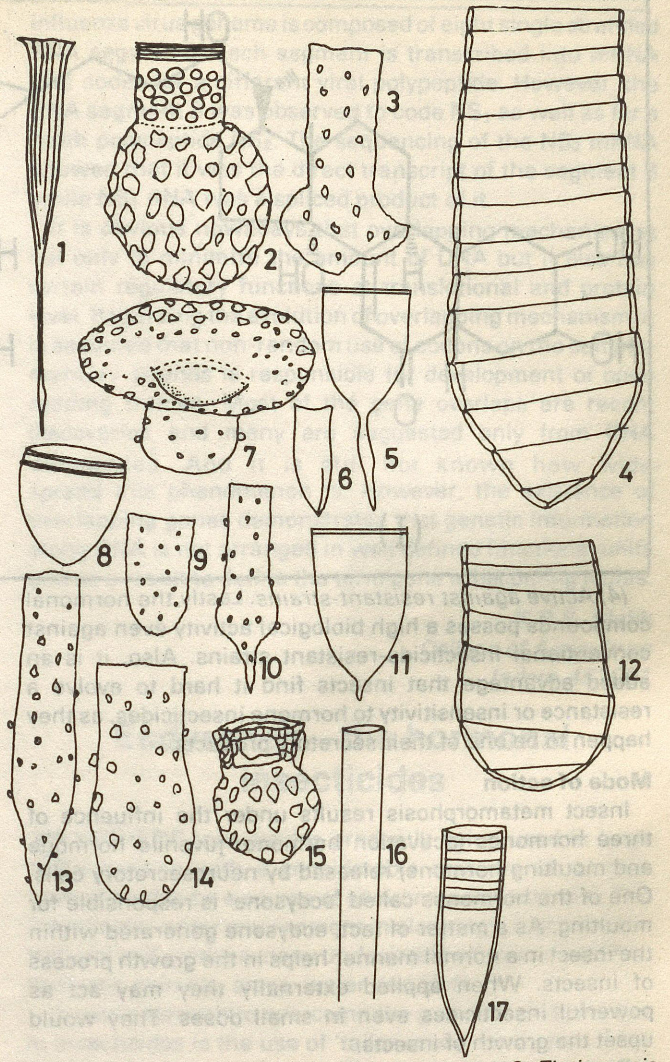

Fig. 2 *1-Rhabdonella* sp., *2- Codonellopsis* sp., *3- Tintinnopsis nordqvisti, 4- Coxliella annulate, 5- Favella philippinesis, 6- Amphorellopsis acuta, 7- Tintinnopsis mortensenii, 8- Metacylis jorgensenii, 9- Tintinnopsis sacculus, 10- Tintinnopsis tocantinesis, 11- Favella philippinensis, 12- Coxliella ampla, 13- Tintinnopsis cylindrica, 14- Tintinnopsis tubulosa, 15- Distyocysta seshaiyai, 16- Eutintinnus tenuis, 17- Helicostomella longa.*

Ocean and cold seas through seasonal currents. Studies at the east coast of India have reported rich fisheries due to tintinnid abundance. Large scale investigations on this unique protozoan group are therefore needed to help identify areas of rich fishery potentials.

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NEWS & NOTES

Ten years of *R.V. Gaveshani*

INDIA's first oceanographic research vessel *Gaveshani* completed 10 years of successful operation in February 1986. The vessel belonging to the National Institute of Oceanography, Goa, of the Council of Scientific and Industrial Research, was formally commissioned on December 31, 1975 but started scientific cruises in February 1976. Prior to this, not much could be achieved in oceanographic research for want of a research vessel and hence the commissioning of the vessel gave much needed impetus to the oceanographic research in India.

R.V. *Gaveshani* was a hopper barge but redesigned and converted into a research vessel at the Garden Reach Workshop, Calcutta. This medium sized vessel has been equipped for multidisciplinary oceanographic work during all seasons and is stabilised against rolling. The 68.33 m long ship has an endurance of 25 days and accommodation for 19 scientists and 51 ship's officers and crew. Since 1976, the *Gaveshani* has been continuously cruising in the Northern Indian Ocean attempting to unravel its mysteries. So far, 160 cruises have been completed. On an average the ship spends about 230 days in a year at sea. The ship has paid goodwill visits to Malaysia, Mauritius, Sri Lanka and Seychelles.

During these cruises, more than 3000 stations have been worked out and a large amount of data on physical, chemical, biological and geological aspects have been collected to enhance our knowledge about the Indian seas. Some of the major contributions made by *Gaveshani* in various fields are summarized here in brief.

Living resources

The biological characteristics of Indian waters have shown that the present marine fish catch of 1.5 million tons can be easily doubled. New spawning and rich fishing grounds have been identified off Gujarat, Pondicherry and Lakshadweep by estimating the primary and secondary productions. The bottom living animals and seaweeds have been mapped and the role of bacteria in marine food cycle has been studied.

Non-living resources

During one of the cruises of *Gaveshani*, India's first sample of polymetallic nodules were scooped up from the Central Indian Ocean on January 26, 1981. These nodules can substitute the import of copper, nickel and cobalt in addition to plenty of iron and manganese. This made India the first among the developing countries and seventh in the world to achieve this distinction.

Surveys also located placer deposits of ilmenite on the Konkan coast to the tune of about 2 million tons.

The investigations on *Gaveshani* were extremely useful in mapping out the sea bed mineral resources in the continental margin of India.

Pollution control and monitoring

R.V. *Gaveshani* has carried out observations along the oil tanker routes across the Arabian Sea and the Bay of Bengal to study (i) oil slicks, (ii) petroleum residues (tar-like material), and (iii) dissolved and dispersed hydrocarbons. The studies concluded that the Indian seas are affected by oil pollution but not to any alarming state as yet.

The ship was deployed under several sponsored projects to monitor pollution in Indian waters. Physical, chemical and biotic factors have been studied to suggest suitable discharge points for industrial effluent and sewage.

Monsoon studies

Gaveshani participated in the programme of monsoon experiment (MONEX-79) sponsored by Government of India as a part of global programmes. The ship undertook six cruises in the Arabian Sea and the Bay of Bengal and collected very helpful oceanographic and meteorological data of great importance in understanding the monsoons which is so vital for India.

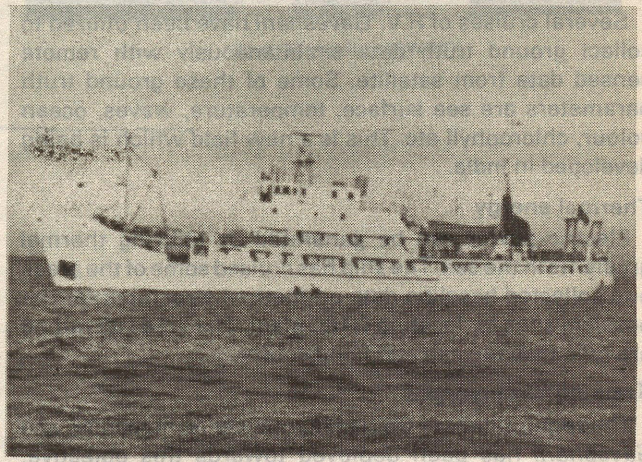
Development of harbours

The ship has contributed significantly towards the development of harbours on both the coasts of India by locating anomalous objects to facilitate navigational activity. Such main harbours being Visakhapatnam, Mormugao, Cochin and Mangalore.

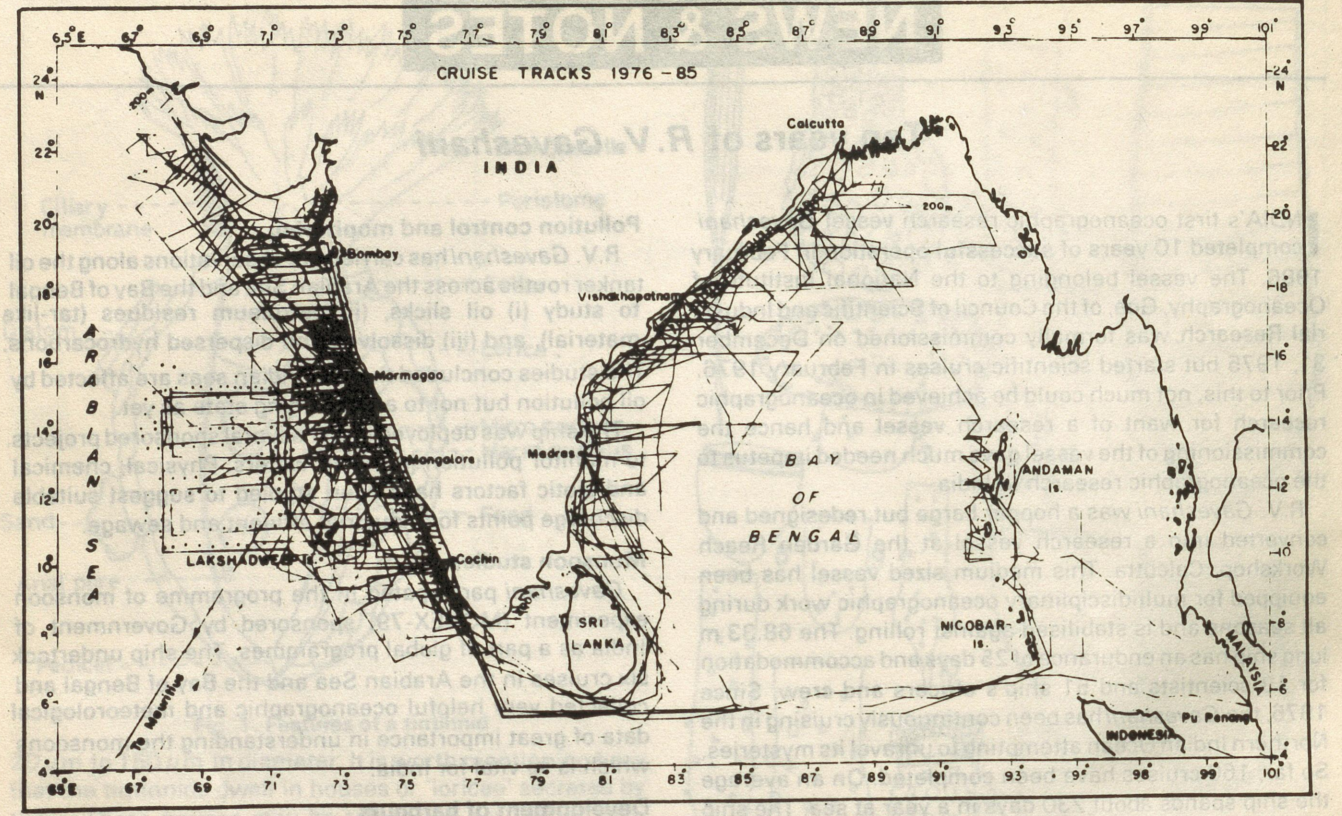
Offshore oil fields

One of the very important surveys carried out by *Gaveshani* is in the Bombay High, off Gujarat and other areas for the development of offshore oil fields for the Oil and Natural Gas Commission. This includes precision work like:

(i) Survey and recommendation of pipeline routes from Bombay High to Bombay—on one of which the ONGC laid the pipeline to transport crude oil and gas to shore.



R.V. Gaveshani



Cruise track of *R. V. Gaveshani* showing area covered in ten years

(ii) Pipeline route from Bassein to Tarapur and Hajira in Gujarat.
(iii) Various surveys for designing production platforms.
(iv) Surveys for location of lost well heads.
(v) Surveys for fixing the position and jacking up of drill ships like *Sagar Samrat, Gettysburg, Shenandoah* and *Chancellor's ville*.
(vi) Control of biofouling of offshore installations.

This indigenous technology has developed self-reliance and saved the country considerable amount of foreign exchange in millions of rupees since this would have been done otherwise by foreign agencies.

Remote sensing

Several cruises of R.V. *Gaveshani* have been utilized to collect ground truth data simultaneously with remote sensed data from satellite. Some of these ground truth parameters are sea surface, temperature, waves, ocean colour, chlorophyll etc. This is a new field which is being developed in India.

Thermal energy

Electric power can be generated by utilising thermal gradients in the sea. The ship has cruised some of the areas and collected baseline data on thermal structures for the possible sites for locating OTEC plant. The areas identified are off Lakshadweep and Pondicherry.

Training of personnel

The requirement of trained manpower is increasing and *Gaveshani* has been deployed towards this objective. Special cruises have been conducted for fresh graduates and scientists from other organisations and universities for on board training in operation of oceanographic instruments, collection and analysis of data. A large number of scientists from the universities of Calcutta, Andhra, Cochin, Annamalai, Bombay, Delhi etc. have been trained.

International activities

The ship has been deployed to work in the exclusive economic zone of Sri Lanka, Mauritius and Seychelles. This has been done at the request of these Governments. Special surveys were conducted for polymetallic nodules and seaweeds in EEZ of Mauritius and Seychelles in addition to other oceanographic parameters for these countries.

Besides these, the ship during these years has been fully utilized and it has been possible to study for the first time the Andaman Sea and the Lakshadweep Sea. The scientific papers on these two areas have been brought out as special publications. The work on R.V. *Gaveshani* has therefore been extremely useful not only in enhancing knowledge of our seas but also to utilize the sea more wisely. R.V. *Gaveshani* can well be considered as a boon for India and the Indian oceanographers.

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Awards under ISCA young scientists programme

INDIAN Science Congress Association has introduced a programme for the benefit of young scientists since January, 1981. The programme enables young scientists to present their proposed research work during the annual sessions of the Science Congress with opportunities to exchange ideas in the relevant scientific problems with their counterparts and specialists. For excellent presentations, 20 such scientists are given awards, called ISCA Young Scientists Award.

Only members of the Association are eligible for consideration for the award. The upper age limit of the candidates for the award is 30 years as on January 1 of the session. For further particulars please contact ISCA office at 14, Dr. Biresh Guha Street, Calcutta-700017.

Professor Hira Lal Chakravarty awards—1986

APPLICATIONS in prescribed forms are invited from Indian Scientists, below 40 years of age on December 31, 1985 and with Ph. D. degree for outstanding published work in any branch of Botany for Professor Hira Lal Chakravarty awards of Rs. 4,000/- each given by the Indian Science Congress Association. Forms and necessary information are available at the Indian Science Congress Association, 14, Dr. Biresh Guha Street, Calcutta-700017. Last date of submitting application is July 15, 1986.

V.Ramalingaswami made FRS

PROF. V. Ramalingaswami, Director-General, Indian Council of Medical Research, New Delhi has been elected a Fellow of the Royal Society of London. Currently he is also Chairman of the Global Advisory Committee on Medical Research of the World Health Organisation, Geneva.

With an illustrious career spanning over three decades, Prof. Ramalingaswami is an eminent authority in the field of human malnutrition and has made outstanding contributions in these areas. He is regarded a world authority in the pathology of nutritional diseases and has made major contributions in the field of liver diseases in the tropics.

Born in Srikakulam, Andhra Pradesh, on August 8, 1921, Prof. Ramalingaswami did his MBBS and MD from Andhra University in 1944 and 1946 respectively. He obtained his D.Phil. in 1951 and D.Sc. in 1967, both from Oxford University. He is Member and Fellow of a number of learned professional societies including the Royal College of Physicians and the Royal College of Pathologists, London. He is also recipient of a number of honorary Doctorates and distinguished awards and medals including the Shanti Swarup Bhatnagar Award of the CSIR. He has been President of the Indian National Science Academy, New Delhi, during 1979-1980. As Director of the All India Institute of Medical Sciences, New Delhi from 1969 to 1979, he took the Institute to a new height of excellence.

Prof. Ramalingaswami

MEDICAL NOTES

Lasers in medicine

IT makes no difference if we consider 'Laser' as unearthly power. Being a source with high degree of monochromaticity, high power density, high directionality, low beam spread and high degree of temporal and spacial coherence, laser has become one of the most useful tools in medical field. In the two decades since its invention, laser has undergone an interesting and dramatic transformation. A wide variety of gas, solid-state, diode, free electron and other lasers have been developed. Each shines at a different wavelength, some pulse on and off, others operate continuously.

As laser is monochromatic in nature, it demonstrates the wavelength selectivity in a variety of subjects. The extremely short pulses offered by a type of lasers provide the means to study rapid chemical reactions within biological systems. In 1968 scientists had observed that photosynthetic reaction rates were 20%-30% greater in laser-light than in the presence of the same intensity of non-coherent light (may be or may not be the ordinary light). The nearly ideal collimation and focussing properties (coherence properties) of laser beam make it a microsurgical tool at the cellular level. For example, ruby laser can focus to an effective beam diameter of 1.5 μm-2.5 μm, while argon laser produces an effective beam diameter of 0.6 μm-0.8 μm.

In ophthalmology

Lasers are commonly used for delicate surgery inside the eye. In treating blood vessel disorders due to diabetes, doctors prefer a fine beam of argon laser light. The light is aimed through the pupil of eye. Upto 2,000 tiny laser burns are made very closely around the back portion of retina. These "laser welds" prevent harmful growth or rupture of new, unwanted blood vessels. The low-powered CO_2 lasers are often the surgeon's "Light scalpel". The potential advantage of a light scalpel is that it cauterizes as it cuts. The heat from the laser beam seals off small blood vessels, thereby reducing the amount of bleeding. It cuts cleanly and sterilizes at the same time. For the benefit of glaucoma patients also, there is now a promising new laser treatment. In glaucoma patients, the fluid of the inner eye does not drain as it should. To relieve open angle glaucoma, surgeons beam very short pulses of laser light into the eye and place 100 small burns in a full circle around the trabecular meshwork surrounding the cornea. Then the pressure inside the eye is reduced and the fluid is drained out. One more application of laser is in retinopathy. When non-coherent light energy is absorbed by the melanin granules within the retinal epithelium and choroid, the light energy is converted into heat and so produces thermal coagulation of protein. This causes the formation of lesions and scars. But if the red wavelength of a ruby laser is absorbed by melanin granule, it is observed that the lesions are produced in smaller diameters relative to those produced due to non-coherent light. So less damage is produced in the peripheral tissues surrounding the light beam. The ruby laser is one of the major tools in the field of retinopathy. Its applications are compartmentalized into: (i) retinal detachment, (ii) reduction of edema in macula; and (iii) diabetic retinopathy. Recent studies have shown that greater success can be achieved by treating diabetic retinopathies with argon laser than with ruby laser. The reason for this is that hemoglobin does not absorb 6943A^0 of ruby laser efficiently.

In pathological conditions

Endometriosis, a disease that appears in female reproductive system, can be cured by beaming a 2W argon laser. In this disease, excess growth of tissues blocks the reproductive tract and causes infertility. The growth rate of bacterial colonies can be counted by means of He-Ne laser. The surfaces of the individual particles (colonies) scatter the laser beam and the angle of scattering is measured by a photometer. It has been found that the formation of a colony from a single *E. coli* bacterium could be recorded over a period of only four hours.

Laser microprobe emission spectroscopy is a valuable tool for the analysis of elements in single cells. By means of this technique the nuclei of freeze-dried sections of liver and kidney, red blood cells and rat spermatozoa are evaluated. This system is sufficiently sensitive to detect as little as 10^{-14}g to 10^{-16}g of the elements such as calcium, magnesium, zinc and iron, etc. This is an aid to diagnose a pathological condition.

Lasers have brought a new frontier to neurosurgery. They have made some inoperable tumors operable and high-risk tumors less high risk. At several major medical centres in the U.S.A. and Japan, lasers are being used experimentally to combat cancerous tumors without surgery. Photoradiation therapy also depends on laser as a light source. In this treatment, patient is injected with photosensitive chemical, called hematoporphyin derivative (HPD), that lodges in the malignant tissue. When the tumor is exposed to red light from a tunable dye laser, it creats a toxic photochemical reaction that destroys the cancerous cell. It is especially effective on patients who have tried every other treatment unsuccessfully. To identify lung cancer, the patient is injected with HPD, and laser light is channelled to the lungs through a fluorescence bronchoscope. If fluorescence is observed, the patient has cancer.

In 1967, it was reported that the strawberry angiomass in infants respond favourably to ruby laser energy densities of 40-50 J/cm^2. In adults excessive development of capillaries in the dermis causes portwine stain. Treatment of this portwine stain with ruby laser of energy 50 J/cm^2

—60 J/cm^2 showed significant lightening associated with very little scarring. The growth rate in mice can be enhanced by means of laser treatment. By exposing a strain of tetraploid Ehrlich ascites tumor cells to a laser energy of 0.2 J/cm^2 — 1.0 J/cm^2, a stimulation in the growth rate is observed.

In man the types of tumors which seem to respond best to laser treatment are melanomas, angiosarcomas, basal cell epitheliomas, squamos cell epitheliomas, lymphomas, vascular tumors, matastates of bronchogenic carcinomas and gliobastomas multiforme. There is some evidence that the response of tumors depends upon the wavelength of laser used. When a He-Ne laser at only 10 mW of power was used, the whole tumor disappeared. Lasers may be also used to fire extremely precise light pulses at DNA molecules altering the structures of chromosomes and repairing defective genes. The very properties that make lasers dangerous-power and heat—are also being used to destroy some kinds of brain and spinal tumors. To eradicate transplantable tumors, neodymium, continuous wave argon CO_2 lasers with high energy are readily acceptable tools.

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AIDS and associated controversies

NO other disease in the contemporary world has attracted such concern and wide publicity as AIDS. The AIDS story started in the mid-1981 and ever since has been hitting the headlines off and on. The disease was first reported by a team of American doctors who found a rare type of pneumonia in some young male homosexuals. It was a surprising observation as this type of a disease caused by a parasite *Pneumocystis carinii* can infect only patients suffering from a serious defect in immunodefence system. They named the disease Acquired Immuno Deficiency Syndrome (AIDS). The disease showed a symptom complex of chronic fever, nocturnal sweating, lymphatic ganglion (lymphadenopathy), etc., which may or may not be associated with one another. A frantic hunt for homosexuals revealed some rare diseases they were suffering from. The discovery spread terror in the world of homosexuals. But before long, it was realized that heterosexuals were also susceptible to the disease. AIDS was noticed in some patients who had received blood from blood banks. The disease was also noticed among men and women having multiple sexual partners. The spread of the disease was marked mainly in the U.S.A. and Western Europe, especially in their big cities with a sizeable number of homosexuals. Thanks to wide publicity, several countries imposed preventive measures. China banned import of blood from the West and some Asian countries restricted import of even items like t-shirts!

In the midst of a global fear, scientists in the West began studying the disease in detail. Investigations revealed that, in addition to the U.S.A. and Western Europe, Africa also has AIDS victims. Western countries are taking great pains to propagate the theory that AIDS originated from Africa, and that they (the Westerners) are mere victims of the infection spread by Africans.

How the disease acts

If any foreign body enters blood-stream, specific serum-soluble proteins, called antibodies, are usually generated. All pathogenic microbes are also foreign bodies and are called antigens (*antibody generators*). The purpose of an antibody is to combine with its antigen and render it harmless. The interaction called antigen-antibody reaction is an important part of the defensive mechanism of a body. The antigen-antibody reaction is as specific as reaction between enzymes and substrates.

Two kinds of lymphocytes, viz., B-lymphocytes and T-lymphocytes, are associated with secretion of antibodies. In the case of AIDS victims, T-lymphocytes get affected. The defect in immunodefence is actually due to a gradual loss of T_4-lymphocytes, whose function is to stimulate multiplication of B-lymphocytes. Stimulation is induced through a soluble mediator called interleukine-2 (IL-2), produced mainly by T_4-lymphocytes. Production of this IL-2 is greatly disturbed in AIDS patients, which explains fall in lymphocyte population and weakening of the body immuno-defence. So, it is not surprising that a great majority of victims succumbs to "opportunistic infections" including *Pneumocystis carinii*, a lung infection; Kaposi's sarcoma, a virulent skin cancer; candidiasis, a fungal condition affecting mouth and esophagus; cryptosporidiosis, resulting in prolonged diarrhoea; and taxoplasmosis, caused by a protozoan infecting brain and lungs. These infections often prove fatal.

The controversy

Fortunately or unfortunately, there were some rare but indisputable cases of transmission of AIDS to haemophiliacs who had received blood from blood banks. Since blood in a blood bank is treated and filtered, chances of bacteria or fungi causing the infection is out of the question. So it was supposed that the causal agent could be a virus. American researchers believed that the Human T Leukemia Virus (HTLV) could be the agent. Their assumption was based on certain experimental observations in cats and mice. They confirmed their hypothesis by showing that blood of AIDS patients contained antibodies that react to an antigen present on the surface of cells affected by HTLV type I. Subsequently, a virus was also isolated. But epidemeological data on HTLV did not tally with the data regarding AIDS. The American researchers explained that the virus could be a new variant.

In 1983, a team of French scientists led by Luc Montagnier of Pasteur Institute, Paris, isolated from blood samples of AIDS patients (beginning stage) a virus which was different from HTLV. They called it Lymphadenopathy Associated Virus (LAV) and characterized the new virus. A year later, Robert Gallo and others of National Cancer Institute in the U.S.A. isolated a virus and gave it the name HTLV-III. They believed that the virus belonged to HTLV family. The work of Gallo was much publicized and he was credited with the discovery of AIDS-causing virus. But, clearly, this virus was no different from the one discovered by the French group. The latter group maintained that the virus in question is markedly different and cannot be placed in the HTLV family. In the international congress held recently at Atlanta in the U.S.A., a large consensus was evolved among virologists and molecular biologists in favour of the French argument. It was also observed that the virus stock may have genetic variations in the envelope around its nucleoid. The French group suggested to keep the generic name LAV (Lymphadenopathy AIDS Virus)—the two terms explaining the two diseases it causes—in the nomenclature of virus, which is now in the process.

The origin

From where the virus came is still under speculation. Some believe that the origin was in chimpanzees and later might have invaded human beings. It is probable that the virus first appeared in Africa and caused epidemic in sporadic patches. Extensive mingling of rural people with urban areas might have created a fertile zone for the virus multiplication which subsequently moved to the U.S.A. and Europe. Two things contributed richly to the spread of the dreaded virus. The frequency of vaginal infection is high in Africa and the second is in the U.S.A. where there is a sizeable homosexual population with their anal mucous membrane having small lesions.

The Indian scene

Sexual behaviour and life-style in India/normally shall not permit the spread of the dreaded venereal disease. Intravenous drug injections, another possible cause of AIDS infection, is also rare in India. But at the same time, careful watch should be maintained over "risk groups", viz., occupants of redlight areas, and homosexuals. Recently, reports of AIDS victims have come from Kovalum beach, perhaps through some foreigners. Some precautionary measures should be taken without delay. Any lapse or inaction could mean a disaster. Spread of the epidemic stands a better chance in India through blood transfusion which may affect the least suspected.

Some precautionary measures

The donor's blood should be screened to make sure that it is not contaminated or infected. This is no easy job, though. Recently, some immunochemical tests such as ELISA (Enzyme Linked Immuno-Sorbent Assay) have shown some promise (for details, see *Science Reporter* November '85, page 418). There should be periodic sample surveys especially of risk groups. Any positive indication should immediately be given proper medical care. Presently, some antiviral medicines are in vogue, but drug dose and combinations are still under trial. A reliable instant cure is a far cry.

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Fascinating properties of number 13

MOST people think that 13 is an unlucky number. So whenever this number comes, one immediately conjures up some thought connected with bad luck. The number 7 is similarly considered very auspicious. But all these are just superstitions. They are not based on any scientific facts. From mathematical point of view number 13 exhibits many interesting and fascinating properties. Unravelled below are some of them.

(1) Number 13 is the smallest prime number which can be expressed as the sum of the squares of two primes, e.g.,

$$13=2^2+3^2$$

(2) From number 13, subtracting the sum of its digits one gets a perfect square number:

$$13-(1+3)=9=3^2$$

(3) To the number 13, if we add the product of its digits we are again led to a perfect square, i.e.,

$$13+(1\times 3)=16=4^2$$

(4) Take the square of the number 13, i.e. $13^2 = 169$. Now it can be seen that 169 contains many squares in it, namely,

(a) Sum of the digits of the number 169 is a perfect square and is the square of the sum of the digits of the original number 13, i.e.

$$1+6+9=16=4^2=(1+3)^2$$

(b) Divide the number in two blocks, i.e., 16 and 9. We see that both are perfect squares and also their sum and product is a perfect square:

$$16+9=25=5^2$$
$$16\times 9=144=12^2$$

(c) The number 169 can be expressed as the sum of two squares, viz.,

$$169=13^2=5^2+12^2$$

(d) The number 169 can be expressed by the number of its two blocks, i.e., 16 and 9 which are perfect squares:

$$169=(16+9)+(16\times 9)$$

(5) Number 13 can be expressed as sum of two squares in two different ways as follows:

$$13=2^2+3^2=(18/5)^2+(1/5)^2$$

(6) The smallest number the sum of whose digits is 13, is a perfect square, i.e., $49=7^2$ and $4+9=13$

(7) The smallest square whose last three digits are alike is 1444. The sum of digits of this number is also 13:

$$1+4+4+4=13$$

(8) Number 13 can be expressed as sum of two cubes as follows:

$$13=(7/3)^3+(2/3)^3$$

(9) If we take the cube of 13, i.e., $13^3 = 2197$ and rearrange the digits of the cube 2197, we get the famous Ramanujan's number 1729.

(10) 13 is the average of the prime factors of the famous Ramanujan's number 1729.

i.e., $1729 = 7\times 13\times 19$ and $7+13+19/3=13$

(11) Sum of the numbers from 1 to 13 gives 91 ($\sum_{n=1}^{13} n=91$). This is the smallest number which can be expressed as the sum of two cubes and also as the difference of two cubes, e.g.,

$$91=3^3+4^3$$
$$=6^3-5^3$$

(12) If we place the number 13 before its reverse, i.e. 31 we get a number 1331 which is a cubic number i.e. $1331 = 11^3$

(13) Reverse of the square of 13 is same as the suqare of the reverse of 13, i.e., $13^2 = 169$. On reversing we get 961, which is the square of reverse of 13, i.e., $31^2 = 961$.

(14) Lastly the reciprocal of number 13 gives

$$1/3=0.\underline{076923}\ \overline{076923}\ \underline{076923}$$

i.e., the number 076923 repeating indefinitely. This number 76923 is one of the most curious numbers in mathematics.

On multiplying the number 76923 by successive multiples of 13 one gets

$$76923\times 13=0999999$$
$$76923\times 26=1999998$$
$$76923\times 39=2999997$$
$$76923\times 52=3999996$$
$$76923\times 65=4999995$$
$$76923\times 78=5999994$$
$$76923\times 91=6999993$$
$$76923\times 104=7999992$$
$$76923\times 117=8999991$$
$$76923\times 130=9999990$$

The left hand digits run from 0 to 9 and right hand digits run from 9 to 0. We observe that top number is the same as reverse of bottom number and second number from top, i.e., 1999998 is the reverse of second bottom most number, i.e., 8999991 and so on.

This magical number 76923 contains many other fascinating properties too which can be investigated by those interested in playing with numbers.

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Long years of trees

TREES are the longest living organisms. Longevity of trees is a specific character, but it is also related to environmental conditions. Trees of great longevity have been reported to occur in environments of limited moisture and/or temperature. Extreme longevity is not uncommon to unusually adverse environmental conditions. The reason perhaps is that environment is equally unfavourable for insects and fungi.

Table 1. Longevity of tree species

Species	*Place/country*	*Age in years*
Indian		
Cedrus deodara	Tehri Garhwal, U.P.	704
Dalbergia latifolia	Cochin, Kerala	About 500
Dalbergia latifolia	Anamalais, T.N.	About 600
Pinus roxburghii	Chakrata, U.P.	327
Pinus wallichiana	Bashahr, H.P.	275
Platanus orientalis	Srinagar, J & K	293
Shorea robusta	Saranda, Bihar	168
Tectona grandis	Parambikulam, Kerala	456
Tectona grandis	Anamalais, T.N.	Over 500
Tectona grandis	Kakankote, Karnataka	680
Foreign		
Cedrus libani	Palestine	4,000
Eucalyptus regnans	Australia	394
Ficus religiosa	Sri Lanka	2,200
Pinus aristata	California	4,600
Sequoia sempervirens	California	Over 4,000
Sequoia wellingtonia	California	3,230
Taxus baccata	England	3,000
Zizyphus spina-chirsti	Palestine	1,500

There are wide variations in life spans of trees. Trees like *Sesbania aegyptiaca* may show senescence at 10 years of age, while a deodar tree may live for a 1000 years. After the growth of height has slowed down, a definite leading shoot is lost and an umbrella-shaped crown develops. Thereafter height of trees remains almost constant at a level determined by species and environmental factors. The tree would continue to grow in diameter and volume for a further period, its duration is primarily a specific character. It is also dependent on locality and liability to injury. The normal life length of a tree may also be an influential factor in species competition. A long-lived species has a considerable advantage as it is able to hold to a place once gained and continues to produce seeds for a long period. Physical maturity of the tree is complete when diameter increase stops or is off-set by decay. Symptoms of senescence show in stag headedness, dying of branches, changes in character of the bark, decrease in power to heal wounds, changes in flowering and fruiting behaviour in addition to restricted growth of roots and organs above ground.

The reason for marked differences in longevity is mainly physiological reflected in decrease in productive activity, degeneration of protoplasm and reduced resistance. Decreased moisture supply to leaves in a large tree and greater expenditure of energy on life processes like respiration together with reduced efficiency of the hormonal system are perhaps the causative factors of low longevity.

Age at maturity and ultimate longevity of the trees can be ascertained by studying annual rings. Decay at the core often makes it difficult to obtain a direct count. Some interesting data on longevity of Indian and foreign trees compiled from various records are given in Table 1.

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Rodents — Why do they gnaw?

IT is a common observation that rats and mice cause damage not only to grains and food crops but also to non-food items. They gnaw and nibble at anything and everything. What makes them gnaw?

More than half of all living mammal species belong to the Order Rodentia which includes mice, rats, voles, porcupines, guinea pigs, squirrels, beavers and gophers.

(Continued on page 334)

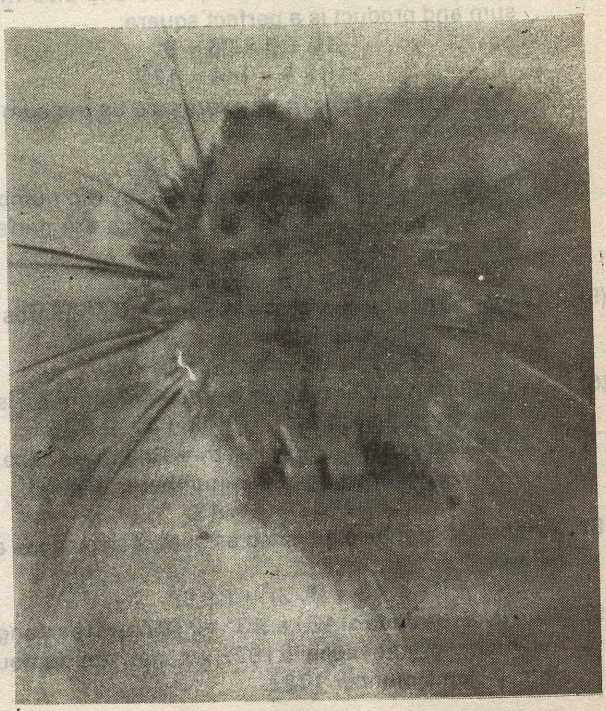
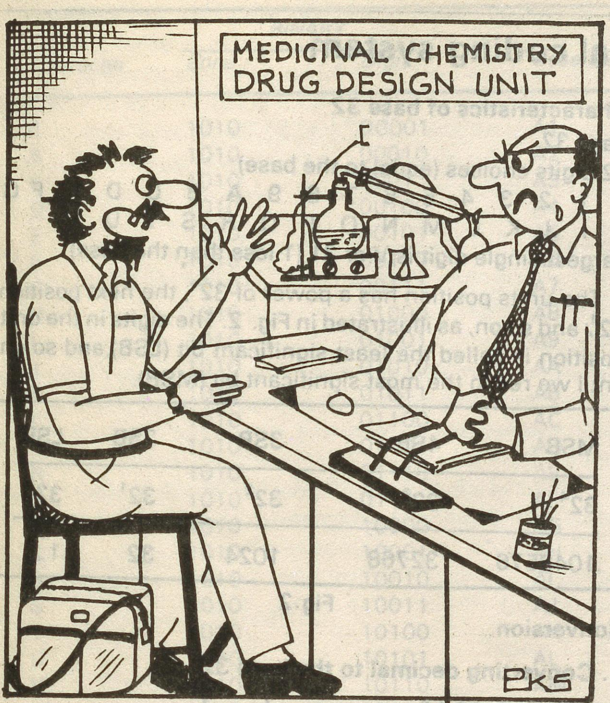
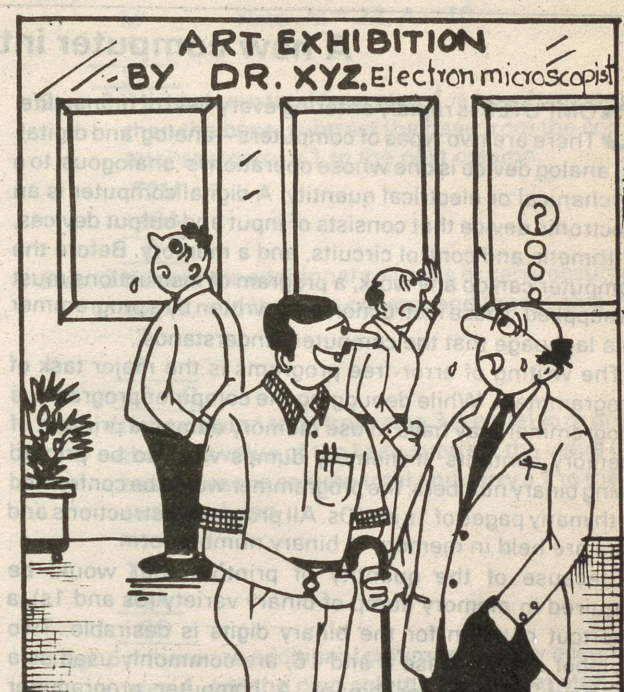


Fig. 1 Characteristic rodents in cisor

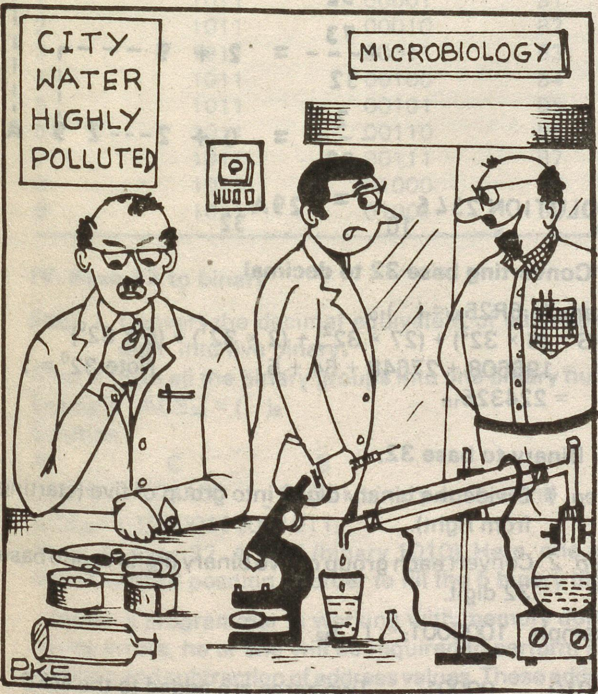
Cartoons *by PRADEEP K. SRIVASTAVA*



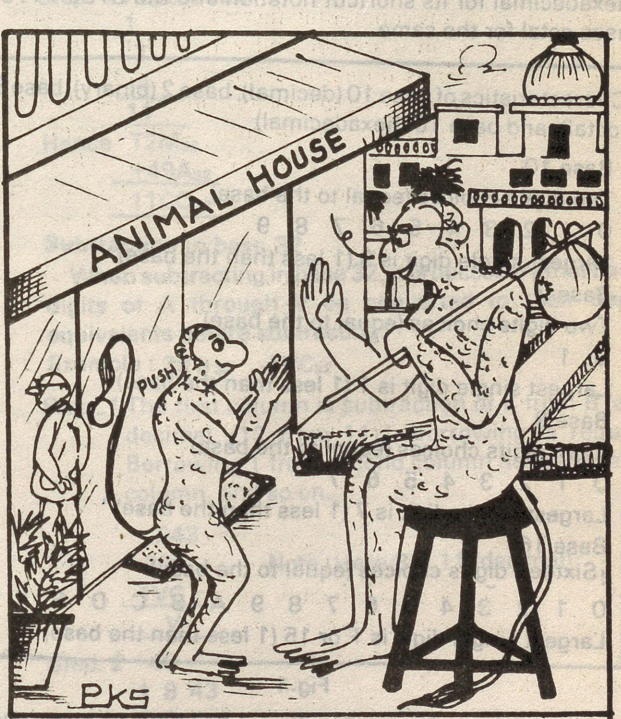
"I am confident of my success in the field. I have got twenty years of experience in designing dresses, furniture, bags, etc., both in India & abroad"



"Not only you, but others also could not see anything, because these paintings are visible only under electron microscope"



"He never takes any risk, not only he uses freshly distilled water but also checks it under microscope before drinking it"



"Be happy son! airconditioned accommodation, excellent food & academic environment, really you took a right decision, to leave the jungle and settle here."

A new computer internal coding system

COMPUTER is rapidly entering every field of human life. There are two types of computers—analog and digital. An analog device is one whose operation is 'analogous' to a mechanical or electrical quantity. A digital computer is an electronic device that consists of input and output devices, arithmetic and control circuits, and a memory. Before the computer can do any work, a program of instructions must be supplied. These instructions are written by a programmer in a language that the computer 'understands'.

The writing of error-free programs is the major task of programmers. While debugging the computer programs, a programmer may have to use memory dumps-a printout of memory contents. If memory dumps were to be printed using binary numbers, the programmer would be confronted with many pages of 1s and 0s. All program instructions and data are held in memory in binary number form.

Because of the quantity of printout that would be required in memory dump of binary variety (0s and 1s), a shortcut notation for the binary digits is desirable. Two number system, base 8 and 16, are commonly used as a shortcut notation for binary. A computer programmer therefore will have occasion to deal with binary (base 2), octal (base 8), and hexadecimal (base 16) numbers, as well as decimal (base 10) numbers. The IBM 370 system uses hexadecimal for its shortcut notation and the CYBER 170 uses octal for the same.

Characteristics of base 10 (decimal), base 2 (binary), base 8 (octal), and base 16 (hexadecimal)

Base 10
Ten digits choices (equal to the base)
0 1 2 3 4 5 6 7 8 9
Largest single digit is 9 (1 less than the base)

Base 2
Two digits choices (equal to the base)
0 1
Largest single digit is 1 (1 less than the base)

Base 8
Eight digits choices (equal to the base)
0 1 2 3 4 5 6 7
Largest single digit is 7 (1 less than the base)

Base 16
Sixteen digits choices (equal to the base)
0 1 2 3 4 5 6 7 8 9 A B C D E F
Largest single digit is F or 15 (1 less than the base)

Fig. 1

Base 32 is so far not familiar in the field of computer technology, and no computer uses base 32 for its internal coding in a memory dump. The development of base 32 is as follows:

Characteristics of base 32

Base 32
32 digits choices (equal to the base)
0 1 2 3 4 5 6 7 8 9 A B C D E F G
H I J K L M N O P Q R S T U V
Largest single digit is V or 31 (1 less than the base)

The units position has a power of 32^0, the next position 32^1, and so on, as illustrated in Fig. 2. The digits in the unit position is called the least significant bit (LSB), and so on until we reach the most significant bit (MSB).

MSB	4SB	3SB	2SB	LSB
32^4	32^3	32^2	32^1	32^0
1048576	32768	1024	32	1

Fig. 2

Conversion

1. Converting decimal to the base 32

EXAMPLE $2346_{10} = (\quad)_{32}$

SOLUTION :

$$\frac{2346}{32} = 73 + 10$$

$$\frac{73}{32} = 2 + 9$$

$$\frac{2}{32} = 0 + 2 \; \text{---} \; 2 \; 9 \; A$$

SOLUTION $2346_{10} = 29A_{32}$

II. Converting base 32 to decimal

Example: $6R25_{32} = (\quad)_{10}$

LHS $= (6 \times 32^3) + (27 \times 32^2) + (2 \times 32^1) + (5 \times 32^0)$
$= 196608 + 27648 + 64 + 5$ Note $32^0 = 1$
$= 224325_{10}$

III. Binary to base 32,

Step. 1. Divide the binary digits into group of five (starting from right).

Step. 2. Convert each group of five binary digits to one base 32 digit.

Example : $1000001_2 = (\quad)_{32}$

00010	00001	Two zeros are added to the MSB positions in order to fill the most significant base 32 position)
2	1	

$1000001_2 = 21_{32}$

Table 1. The numeric and alphabetic characters in the new version

Character	BINARY Zone	Digit	Base 32
A	1010	00001	A1
B	1010	00010	A2
C	1010	00011	A3
D	1010	00100	A4
E	1010	00101	A5
F	1010	00110	A6
G	1010	00111	A7
H	1010	01000	A8
I	1010	01001	A9
J	1010	01010	AA
K	1010	01011	AB
L	1010	01100	AC
M	1010	01101	AD
N	1010	01110	AE
O	1010	01111	AF
P	1010	10000	AG
Q	1010	10001	AH
R	1010	10010	AI
S	1010	10011	AJ
T	1010	10100	AK
U	1010	10101	AL
V	1010	10110	AM
W	1010	10111	AN
X	1010	11000	AO
Y	1010	11001	AP
Z	1010	11010	AQ
0	1011	00000	B0
1	1011	00001	B1
2	1011	00010	B2
3	1011	00011	B3
4	1011	00100	B4
5	1011	00101	B5
6	1011	00110	B6
7	1011	00111	B7
8	1011	01000	B8
9	1011	01001	B9

IV. Base 32 to binary

Step. 1. Convert the decimal equivalent of each base 32 digit into five binary.

Step. 2. Run all the binary groups into one binary number.

Example : $ACB_{32} = (\quad)_2$

Solution :

A C B
01010 01100 01011 (binary equivalent)
$ACB_{32} = 010100110001011_2$

Note : In base 32, A = 10 (binary 1010). Here, one zero is added to MSB position in order to fill the 5 binary digits.

When a programmer is working with memory dumps to locate errors, he or she will be required to perform simple addition and subtraction of address values. These addresses will be either in octal or hexadecimal, depending upon the computer's memory organization. The following example illustrates the addition and subtraction in base 32 if it is used.

Addition in base 32

Example: $T2M_{32} + 49A_{32} = (\quad)_{32}$

Step. 1 Add the first column rght most

M
+A
32

Note: M = 22, A = 10

Step. 2 If the column total from step. 1 is equal to or greater than the base, subtract the base from the column total and carry a 1 to the next column.

T2M
+49A
0

Step. 3 If there are additional columns or carry occurred in step 2, add the next column and repeat step 2.

2
9
12 = C

Step. 4 If the column total from step 3 is equal to or greater than the value of the base, subtract the value of the base from the column total and carry a 1 to the next to the column.

1
T2M
49A
CO

Step. 5 If there are additional columns or carry occurred in step 4, add the next column and repeat step 2.

T Note: T = 29
4
33

Step. 6 Repeat step 2.

1
T
4
11

Hence $T2M_{32}$
$+49A_{32}$
$11CO_{32}$

Subtraction in base 32

When subtracting in base 32, it is necessary that base 32 digits of A through V be converted to their decimal equivalents before subtracting.

Example : $29B_{32}$ $-1VC_{32}$

Step. 1 The first column is subtraction of C from B (or, in decimal 12 from 11). Borrowing is required. Borrowing 1 from second column adds to the first column, and so on.

843
29B
-1VC
V

Note : Here B = 11 (decimal)

Step. 2 40
1 8 43
2 9 B
-1 V C
0 9 V

Hence the answer is $09V_{32}$

Character codes

It is quite interesting to see how this new base 32 version will be used as an internal coding system in future computers.

All computers use coding system to hold data in memory. Computer has codes for alphabetic characters, (A through Z), numeric characters (0 through 9) and special symbols (>,<, %, etc).

The Hollerith code has been used for recording data in punched cards, but this code is not used as an internal coding system, because it requires 12 bits or binary digits to record each character of data. There are other, more efficient coding systems that require smaller bit group to indicate a character. However, many of these coding systems are based upon the Hollerith card code.

Some of the internal codes, used in present computers, are Binary Coded Decimal Interchange Code (BCDIC), Extended Binary Coded Decimal Interchange Code (EBCDIC), American Standard Code for Information Interchange (ASCII), and ASCII-8.

EBCDIC is 8-bit code, that is, it requires memory groups of 8 binary digits. The first 4 bits represent the zone code and the last four the digit code. It has 256 possible characters.

ASCII is a 7-bit code which is widely used in American computers. There are 128 unique bit combinations or 128 possible characters. ASCII-8 is 8-bit code and there are 256 possible characters. ASCII and ASCII-8 use hexadecimal for its shortcut notation.

What is important is that no computer uses more than 8-bit code and base 32 for its internal coding system. A new version of the internal coding system is described below. The new code uses base 32 for its shortcut notation and it uses 9-bit group, rather than a group of 7 or 8. The code capacity is extended to 2^9 (i.e.,512) character choices. The zone value for alphabetic characters is equal to 10 (binary 1010) and that for digit value is 11 (1011).

The digit values for alphabetic characters run from 1 (binary 00001) through 26 (binary 11010). The digit values for numeric characters run from 0 (binary 00000) through 9 (binary 01001)

Advantages

1. Two numbers are required to represent the zone values for the alphabetic characters in ASCII and ASCII-8, whereas in base 32 only one number is required for the same.

2. In base 32, 2^9 (i.e.,512) possible characters can be had which will be utilised when new requirements develop.

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SCIENCE FOR THE YOUNG *(Continued from page 330)*

Sometimes small insectivores, especially shrews, small carnivores, marcupials, pikas, and some others are confused with rodents. But all rodents are clearly recognizable by their remarkable 'incisors'—the most anterior of the four basic kinds of teeth found in mammals.

Rodents are all gnawing animals (Rodents—take their name from the Latin verb 'rodere' which means 'to gnaw'); they are equipped with a pair of long, curved incisor teeth in each jaw Fig. 1. Canines are absent and there is a space, the diastema, between incisors and premolars. The typical dental formula is 1 1/1; C 0/0; Pm 2/1; M 3/3. The incisors, characteristic of rodents, grow continuously throughout the animal's life, but always remain the same length because of constant use.

It was experimentally observed in the case of gerbils that growth of incisors was 0.4mm/day. As the incisors grow throughout the life period of a rodent the growing incisors, if unchecked, would ultimately pierce the skull causing the death of the rodent. To arrest the growth of the incisors, rodents nibble at whatever hard substance they find in the surrounding enviroment. Only the front surface of an incisor is covered with hard tooth enamel, so the inner side wears down more quickly than the outer one. That ensures the sharp end of each tooth.

Rats and mice readily gnaw through any material that is softer than the enamel of their teeth. The enamel registers 5.5 on the geologists' hardness scale. This includes most building woods, aluminium sheeting, soft mortar, concrete of poor quality and asphalt. Galvanised sheet metal and hardware cloth are generally impervious to attacks by rats and mice and are used as rodent-proofing materials. If a material is not very soft, rodents would be able to grip it with incisors to gnaw. This explains why rodent cause enormous destructions to crops, household articles and hard food grain, telephone cables, etc.

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How to control obesity through diet and exercise

IF you are among those people who say, "Why should I control my weight?", then let me tell you that since you are overweight, you are endangering your health. Obesity increases the risk of hypertension, diabetes, heart disease, stroke, circulatory problems, arthritis and early death. Also overweight keeps you from feeling as good as you should. All it takes to control your weight is a few simple changes in your eating and exercise habits. You should weigh throughout your life what you did when you were 25 years of age.

The advices you should follow are : Lose weight slowly, aim to lose only 2 kg per week. Take atleast 1200 calories per day. Space meals evenly through the day and restrict it approximately to the same quantity; feasting or fasting is certainly not going to be beneficial in the long run as you could become anemic and regain double the present appetite. Do not skip meals as it makes snacks more tempting. Eat slowly, chew each mouthful thoroughly, serve yourself on a smaller plate, and stop eating when you are full.

Food is fuel, the units in food are called calories. The way you measure your waist in inches you measure your food in calories. If we eat more than what we need, we get overweight. The body stores the extra calories as fat and our body weight increases. Fat + protein + carbohydrate = calories. Each gram of fat gives 9 calories, while carbohydrate and protein give for 1 g, 4 calories each. One gram of alcohol given 7 calories of energy. A pound (454 gm) of body fat is equal to 3500 calories. Thus if we want to lose half kg weight each week, we should eat the right kind and amount of food to cut down 500 calories/day. Remember small differences can make a big difference. May be you eat only 50 extra calories/day, but multiply that by 365 days, and you will probably gain 2.25 kg in one year. You can reverse the

Table 1. Calorie count chart

	Ingredients	*Amount*	*Calories*
I.	**Cereals:** Chapati, bread, noodles, dalia, puris, rice suji, poha etc.	1 slice bread (25 gm.)	72
		1 chapati (30 gm.)	72
		1 puri (20 gm.)	72
II.	**Protein foods:**		
	A. Meat, fish, chicken, eggs, dals, legumes, beans	Half cup cooked dals	120
		28 gm. (1 Oz.)—Meat fish for chicken	75
	B. Milk and milk products, including dahi, paneer etc.	240 ml. cow's milk	170
		240 ml. whole milk	260
		¼th cup paneer	75
	C. Nuts and oilseeds: groundnuts, kaju, badam etc.	Nuts—40 gm.	204
III.	**Fat:** Butter, ghee, oils, cream etc.	Fat, one tea spoon (5 ml.)	45
IV	**Vegetables:**		
	Group A: Brinjal, fresh beans, cabbage, cauliflower, cucumber, all green leafy vegetables, radish, tomatoes etc.	If 1 cup (1 serving approximately) is taken from group A vegetables it has negligible calories	—
	Group B: Beet root, carrots, turnip, onion, green peas, pumpkin and potato	One cup of any one group B vegetables	68
V.	**Fruits:** Apple, banana, mango, sapota, pears, citrus fruits, melons etc.	1 small apple	40
		Half medium banana	40
		Half cup mango	40
VI.	**Sugar, honey, sago, jam**	15 gm. of sugar etc.	60
VII.	**Coffee, tea** : Black, and unsweetened	As desired	—
VIII.	**Calorie dense:** (Desserts and Indian sweets) and snacks	a) 1 cup icecream	294
		b) Kachori, laddoo, barfis, gulab jamuns and rasgulla 40 gm. each	250
		c) Kulfi, rabdi and halwa half cup each	600
		d) Chocolate slab—6 pieces	500

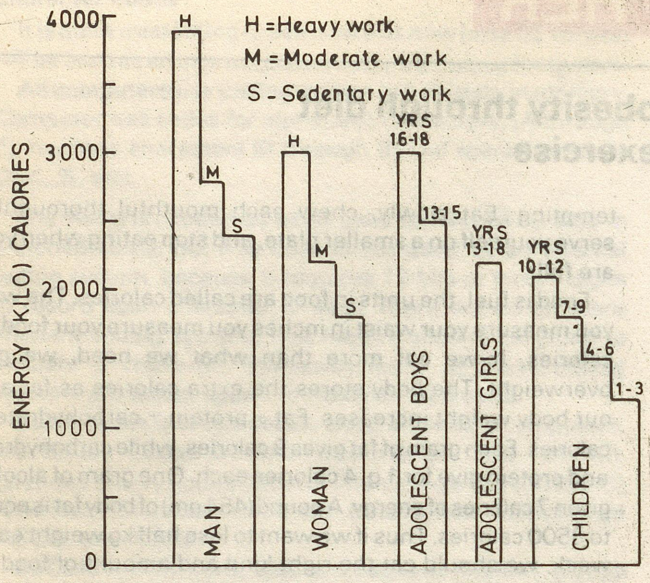

Fig. 1. Normal calorie intake (Carbohydrate : Protein; Fat = 55:15:30% cal.) (Source : Recommendation of Nutrition Expert Group, 1968, ICMR)

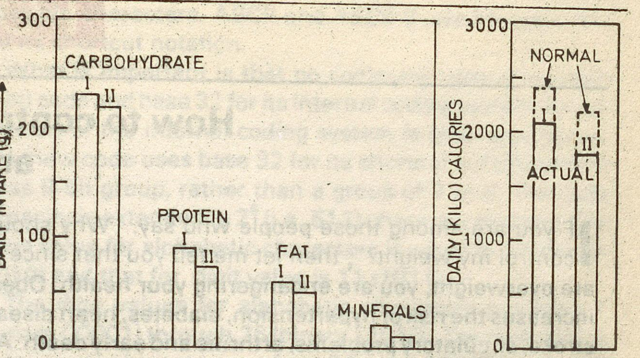

Fig. 2. Typical diets for reducing weight: (i) Sedentary male reduced from 83 kg to 77 kg in 6 months, by taking the following: Wheat flour 70g, Dal 100g, Bread 50g, Bengalgram 25g, Milk 750g, Cooking oil 30g, Salt 5g, Cucumber 80g, Peas 50g, Cauliflower 70g, Spinach 20g, Onion 25g. Lemon 10g, Tomato 50g, Apple 200g, Fish 100g, Egg 20g, Alcohol (100%) 20g per day (non-vegetarian), (ii) Moderate working female reduced from 73 kg to 63 kg in 6 months by taking the above foodstuffs except last three items (vegetarian) (Source: Results of actual experiments on two overweight persons)

process just by cutting out a mere 50 calories per day. You can calculate your calorie intake roughly by the calorie count chart given in Table 1.

When calorie intake equals calorie used, weight remains constant. To determine calorie requirements per day, use this thumb rule:

Men : Multiply desired weight (in pounds) by 16.

Women : Multiply desired weight (in pounds) by 14.

Thus for maintaining good health and to look beautiful and radiant, include in your day's menu fresh fruits, salads, well-washed raw vegetables like cucumber and carrots, boiled egg, whole wheat bread or chapati, paneer, murmura, sprouted mung, and fermented foods like idli, dosa, khaman and dhokla.

A sample menu has been specially worked out, which is a balanced diet, to be followed strictly, without exceptions of feasts and fasts. Through this diet it is possible to reduce a considerable amount of weight within weeks.

Full day's total calories are : 1200

For a well balanced diet for full day, include all the food groups in amounts:

Milk Group : 2 to 3 glasses.

Protein/Pulse Group : Serve 2 times/day (1 serving = 100 gm)

Vegetable and Fruit Group : 4 servings/day, include 1 yellow or green vegetable daily, and 1 citrus fruit every day.

Cereal and Bread Group : 3 to 4 servings/day (1 serving = 30 gm e.g. one chapati, while cereal, 1 serving = 1 cup).

For planning a satisfactory diet, the recommendations for daily energy requirement for Indians are shown in Fig. 1 calculated for a man and a woman weighing 55 kg and 45 kg respectively.

Fig. 2 illustrates typical diets for reducing weight gradually over a period of 6 months as tried out successfully by two dieters above 50 years of age. As depicted in Fig. 2, both the

Reducing, balanced diet

	Diet plan	Energy (calories)
Breakfast:	1. Orange juice (1 glass)	40
	2. Skimmed milk (¾th cup) with dalia (100 gm.)	132
	3. One toast	72
	4. Boiled egg (60 gm.)	86
	5. Tea, 1 cup (without sugar)	—
	Total	330
Lunch:	1. Buttermilk/milk (one cup using skimmed milk)	80
	2. Phulkas (2)	144
	3. Pumpkin vegetable (half cup)	32
	4. Peas/rajma thick curry (1 cup)	130
	5. Palak raita (half cup)	80
	6. Tossed salad (with cucumber, tomatoes, carrots, and lemon juice)	100
	Total	566
Snacks:	1. 1 big guava/apples 2 small or ¾th cup mung sprouts with some raw onions chopped and lemon juice.	80
	Total	80
Dinner:	1. Phulka (one)	72
	2. Boiled rice and dahi mix-half cup (served cold)	72
	3. Mixed salad (1 bowl)	80
	4. Cauliflower sabji or any other sabji (from group A vegetables) with soyabean grits (¾th cup)	60
	5. Watermelon (1 cup, diced)	40
	Total	324

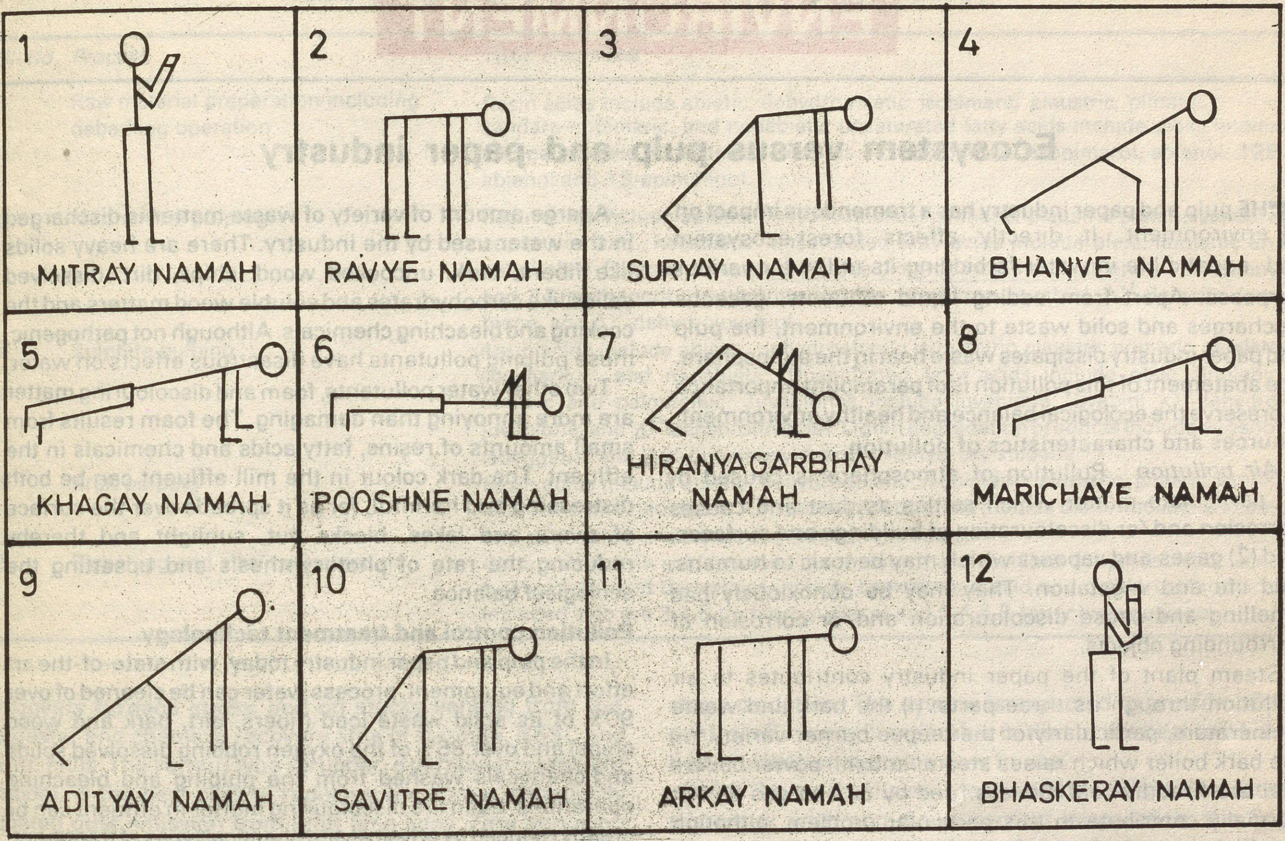

Fig. 3. Surya Namaskar: a cycle of 12 poses to be repeated up to 12 times to control obesity and maintain good health

dieters reduced their daily energy intake by 400 calories each from that recommended for them by ICMR (1982) for adults. This included a brisk walk for half an hour each day.

Physical exercise

Exercise is the second part of weight control. Everything you do uses up calories, but more strenuous the job the more calories you consume. You can use 100 calories in 6 minutes of walking upstairs, 10 minutes of swimming or running, 15 minutes of bicycling, 17 minutes of playing tennis, 24 minutes of doing laundry, 30 minutes of badminton or gardening, 38 minutes of dancing, 20 to 40 minutes of walking outdoors, 40 to 50 minutes of walking around.indoors doing housework, 50 to 65 minutes of standing doing light activity such as ironing, 75 minutes of standing doing nothing and 100 minutes of sitting.

It is ideal if you include atleast 15 minutes of exercise daily. Here it is suggested that daily "Surya Namaskar" early morning is a good practice, which can be learnt studying the 12 poses demonstrated in Fig. 3. It should be done upto 12 times in the same series as shown in Fig. 3.

So manage you calories from today and take up an interesting exercise of your choice. Remember some exercise is better than none. Jog on the spot, or dance to your favourite music, or practice and continue doing Surya Namaskar.

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Ecosystem versus pulp and paper industry

THE pulp and paper industry has a tremendous impact on environment. It directly affects forest ecosystem and aquatic life in water forbidding its utility for various purposes. Apart from adding liquid effluents, gaseous discharges and solid waste to the environment, the pulp and paper industry dissipates waste heat in the atmosphere. The abatement of this pollution is of paramount importance to preserve the ecological balance and healthy environment.

Sources and characteristics of pollution

Air pollution : Pollution of atmosphere is caused by (1) particulate matter which settles as dust and causes corrosion and/or discolouration of buildings and surfaces, and (2) gases and vapours which may be toxic to humans, wild life and vegetation. They may be obnoxiously bad smelling and cause discolouration and/or corrosion of surrounding objects.

Steam plant of the paper industry contributes to air pollution through its three parts: (i) the bark and waste incinerators, particularly of the teepee burner variety, (ii) the bark boiler which raises steam, and (iii) power boilers that are fired by coal. Boilers fired by oil and gas do not normally contribute to this particular problem, although insufficient combustion of oil is indicated by heavy smoke from the stack.

The amount of air pollutants emitted from a pulp mill depends upon what method of pulping is being used, i.e., pollutants vary with the process. The vapours leaving the stock canals carry with them a certain amount of finely divided pulp. The relatively new design of flash drying equipment used to dry ground-wood and other pulps usually allow various amounts of fibrous material to enter the atmosphere at the vents from the various cyclones employed.

Briefly, the main discharges into the atmosphere from pulp and paper industry are as follows:

(i) *Sulphur compounds:* The various sulphur compounds discharged in to the air include malodorous compounds such as hydrogen sulphide, methyl mercaptan, dimethyl sulphide and dimethyl-disulphide and sulphur dioxide.

(ii) *Chlorine compounds* : Chlorine and chlorine dioxide.

(iii) Inorganic dust consisting mainly of sulphates and carbonates and dust of organic nature.

Water pollution

Depending on the process, pulp mills use a maximum of 34,650 gallons of water per ton of kraft pulp and 62,700 gallons per ton of sulphite pulp. Logs may be debarked by high pressure hydraulic jets, the pumps and machines themselves are cooled by a constant flow of thousands of gallons of water. Water is also used in cooking, washing, and as a method of transporting fibers throughout the processing.

A large amount of variety of waste matter is discharged in the water used by the industry. There are heavy solids like fibers, bark, uncooked wood, chips, dirt, dissolved solids like carbohydrates and soluble wood matters and the cooking and bleaching chemicals. Although not pathogenic, these pulping pollutants have disastrous effects on water

Two other water pollutants, foam and discolouring matter, are more annoying than damaging. The foam results from small amounts of resins, fatty acids and chemicals in the effluent. The dark colour in the mill effluent can be both distressing and harmful, for as it spreads over the surface of rivers and lakes, blocks out, sunlight and thereby reducing the rate of photosynthesis and upsetting the ecological balance.

Pollution control and treatment technology

In the pulp and paper industry today, with state-of-the art effort and equipment, process water can be cleaned of over 90% of its solid waste load (fibers, dirt, bark and wood chips) and over 85% of the oxygen robbing dissolved solids and chemicals washed from the pulping and bleaching operations. Even the discolouring matter in effluent can be greatly reduced by physical and chemical types of treatment. Before mill effluent is discharged into public waterways, it can be restored to a non-toxic and aerated condition. With state-of-the art control, the atmosphere around a mill can be saved from a continuous barrage of many tons of soot, ash and gases. Over 99% of particulate emissions and over 95% of gaseous contaminants may be filtered or reused.

Air pollution control

Every mill in the country has to cope with the soot and ash particles emitted from oil, bark and coal-fired boilers. Mills that burn spent liquor for chemical recovery have the added problem of controlling chemically coated fly ash from the recovery furnaces. For the control of particulate matter, the oldest and most widely used devices are mechanical or cyclone dust collectors. They set up a continuous air current that spins particles against walls inside pipes leading to mill stacks. The bits or soot and ash after striking the walls fall back down into a hopper at the bottom of stack from which they are periodically removed. Dust collectors can achieve 80% to 90% removal of large particulate matter.

Scrubbers can remove about 95% of the particulate matter as well as over 90% of the sulphurous gases from the exhaust passing through a mill's stacks. A stream of water sometimes containing chlorine or other chemicals is sprayed through the exhaust, "scrubbing" soot and ash and absorbing large volumes of gaseous compounds. Scrubbers may be used on all coal boilers. They may also be used alone or in conjunction with precipitators on kraft

Table 1. Main toxic chemicals formed in paper industry

Sl. No.	Process	Toxic chemicals
1.	Raw material preparation including debarking operation	Resin acids include abietic, dehydroabietic, isopimarc, plaustric, pimaric, sandara-copimaric, and neoabietic unsaturated fatty acids include oleic, linoleic and palmitoleic. Diterpenes alcohols include pimarol, isopimarol, abienol, 12E-abienol and 13-epimanool.
2.	Mechanical pulping	Resin acids include abietic, dehydroabietic isopimaric, plaustric pimaric sandara-copimaric, and neoabietic unsaturated fatty acids include oleic, linolenic and palmitoleic. Diterpene alcohols include pimarol, isopimarol, abienol, 12E-abienol and 13-epimanool. Juvabiones include juvabione, juvabiol, $\Delta^{1'}$-dehydro-juvabione, and $\Delta^{1'}$-dehydrojuvabiol.
3.	Sulphite pulping	Resin acids include abietic, dehydroabietic isopimaric, plaustric primaric, sandara-copimaric, and neoabietic. Unsaturated fatty acids include oleic, linolenic, linoleic and palmitoleic. Juvabiones include juvabione, juvabiol $\Delta^{1''}$-dehydro-juvabione, and $\Delta^{1''}$-dehydrojuvabiol. Lignin degradation products include eugenol, isoeugenol and 3:3'-dimethoxy-4-and 4'-dihydroxy stilbene.
4.	Kraft pulping	Resin acids include abietic, dehydroabietic, isopimaric, plaustric, pimaric, sandara copimaric and neoabietic. Unsaturated fatty acids include oleic, linoleic, linolenic and palmitoleic and lignin degradation products.
5.	Bleaching and alkaline extraction	Chlorinated resin acids include monochloro- and dichloro dehydroabietic. Unsaturated fatty acid derivatives include epoxystearic acid and dichlorostearic acid. Included also are 3,4,5-trichloroguaiacol and 3,4,5,6-tetrachloroguaiacol.

recovery furnace stacks and on stacks venting from the digester and chemical recovery area of sulphite, NSSC and kraft mills. The venturi type scrubber, a particularly efficient model, is the best control reducing the heavy, chemically coated dust emission from kraft lime kilns. One annoying side effect resulting from the use of scrubbing units is an increase in water vapour emissions. Devices called demisters or demister pads, made of fine mesh, or porous materials may be placed in the neck of the scrubbers to trap large water droplets and help reduce vapour problem.

The electrostatic precipitators are considered one of the most efficient particulate collection devices and can remove upto 99.5% of particulate emissions. A precipitator consists of a box-like structure containing positively and negatively charged rods that create an electric field. It is placed at the entrance to a mill stack and as the gas stream passes through it, each soot particle recieves a charge and adheres to a rod with the opposite charge. From time to time, the rods are rapped and the clinging particulate matter falls to the bottom of the precipitator.

Before the waste liquor enters the first phase of the recovery cycle (the evaporators), while it is still in its unconcentrated or weak condition, it is piped into a black liquor oxidation tower. The tower is packed with a series of metal plates or porous carbon blocks, and as the liquor flows through, stream of air is injected into it. Virtually 100% of odourous gas formation can be prevented at this stage by "Weak black liquor oxidation." In order to achieve more complete odour control, the air should also be injected into concentrated liquor, i.e., by performing "Heavy black liquor oxidation." Combination of these two steps greatly reduces odour.

The molecular oxygen instead of air is being used in one stage oxidation. The system is expected to provide odour control efficiency comparable to that of the best weak and heavy oxidation systems now in use.

With the most efficiently operated black liquor oxidation system or with non-direct-contact evaporation, the final odourous gas emission from the kraft process may be reduced to one part per million in the air. However, since odourous gases are still detectable and distressing at concentrations of one part per billion, no final solution to this form of pollution is now technologically possible.

Primary step

The first step in the treatment of an effluent is to remove solid materials that would cause damage or wear to pumps and other equipment. Following removal of heavy solids, the effluent passes through a large mesh screen or bar screen. These screens are used to protect equipment against wood, bottles, cans and other floating debris. The effluent is now suitable for pumping or gravity transfer to the next stage of treatment. One last step remains, however, before effective treatment of the waste can begin, i.e., neutralisation of pH. The pH control is necessary to protect both metal and concrete surfaces from corrosion and in the case of bio-treatment systems, to ensure that the process works efficiently without creating unnecessary odours.

The primary effluent treatment involves removal of suspended solids with a partial reduction of BOD load and other harmful characteristics of the pH adjusted effluents. The methods suggested are sedimentation, floatation, filtration, coagulation and clariflocculation. They are efficient and economical and should be followed invariably as an essential treatment.

Sedimentation is most commonly used method in the pulp and paper industry. Primary sedimentation can remove

75% to 95% of the settleable solids while also obtaining a 25% BOD reduction. It is a strictly physical process that involves mill effluent to remain still in a settling pond or a large cement clarifying tank until the solid wastes fall to the bottom. The clear water overflows the top. Many clarifying systems are equipped with a skimming device for removal of wood fibers floating on the surface so that they can be fed back into the pulp making operation. While it helps to keep substantial amounts of solid waste from being discharged, no mill equipped solely with screens and "save-alls" can be said to provide full primary treatment.

Chemical treatment employing coagulants such as alum, lime and iron salts is practised in many cases primarily for the removal of suspended solids and partly colour removal, but the high chemical requirement and sludge dewatering and disposal problems make the process unviable.

The accomplishment of primary treatment creates one major subsidiary problem, disposal of the mass of solid wastes that accumulates at the bottom of clarifier. This "sludge" which has a very high consistency can be dehydrated and burned for fuel or simply used for landfill. Unfortunately, as landfill sites become more scarce, the problem of sludge disposal becomes more acute and mills will have to find new uses for sludge.

Secondary "effluent" treatment

Secondary treatment is actually an attempt to simulate, though at a higher rate, the natural oxidation process that takes place in streams, lakes and rivers. Secondary effluent treatment removes 80% to 95% of the dissolved oxygen demanding organic and inorganic materials in effluent. It is a biological process. The micro-organisms eventually convert soluble organic material into carbon dioxide and water or cellular material (biological solids). Among the various forms of micro-organisms, the bacteria are the most important as they represent the major functional unit of the biological system.

The availability of oxygen determines whether a waste water treatment process will be aerobic or anaerobic. If excess molecular oxygen is present, the bacteria present will always metabolize aerobically. If molecular oxygen is absent, the conditions are anaerobic. The absence of dissolved oxygen in waste water creates anaerobic conditions. In this case, the metabolic pattern of the micro-organisms is changed in that the oxygen comes from the organic matter being degraded.

Aerobic lagoons are one of the commonest of treatment systems used for pulp and paper mill effluents. Retention times are generally 5 to 7 days, although slightly shorter or longer times are not unusual

Where adequate space is available, the preferred means for secondary treatment for pulp and paper industry waste is a 5 to 10 days aerated stabilization basin. This type of treatment offers the greatest buffer to absorb plant upset conditions, a very significant advantage over the short retention of activated sludge process. The extended holding time also allows a lagoon to serve as a cooling pond. The aerated lagoon is usually designed with an initial quiescent zone or separate settling pond for removal of any post-clarifier suspended solids and is terminated in a second quiescent zone for settling out biologically generated suspended solids.

The majority of today's installations use floating mechanical aerators with either high speed (direct) or low-speed (geared) drives to introduce oxygen into a lagoon. Molecular oxygen may also be used for aeration purposes where its cost is competitive.

Anaerobic systems are essentially simple, earthen ponds, three to five meter deep with a capacity of about 30 days volume of effluent.

Activated sludge process

Activated sludge process is the commonest form of the so-called high rate system, whereas lagoons are considered low rate system. This process is capable of producing a highly stabilized effluent and is generally applied where land area is limited, since the total effluent retention time including the necessary preclarification is generally 10hrs. or less. The effectiveness of this process depends upon the development of a slurry of biologically active material called activated sludge which is rich in bacteria and oxygen is passed into waste water by giant egg-beater-like aerators. The bacteria quickly attack and break down the waste, adsorb and oxidize organics from the waste water so that within a few hours effluent can be discharged.

The major advantage of the activated sludge system is that it is compact. Its major disadvantage is its high capital and operation cost compared to a lagoon. Sludge bulking, associated with growth of filamentous organisms, is the most frequent and disconcerting operational problem. The presence of bleach plant wastes can also lead to unpredictable upsets in treatment effectiveness. BOD removal efficiency is higher with activated sludge systems, 90% or better, versus 70% to 80% in a lagoon.

Tertiary effluent treatment

The tertiary effluent treatment is a catch all phrase for anything beyond secondary treatment such as the use of chemical treatment methods as well as physical techniques which include micro-screening to separate the micro-size particles, adsorption to remove colouring matter, evaporation and ion-exchange treatment to remove pollutants down to molecular size, and electrodialysis to separate out ionic species from the effluent. The process depends on the nature of waste material.

Spray irrigation

It means that untreated or partially treated effluent is just piped to land near a mill and discharged, a simple way of avoiding the cost of installing adequate water treatment facilities. While the water and its load of organic wastes may have some soil fertilizing value, the chemicals and concentrations of salts in the effluent are more likely to degrade soil quality. Upon passage through the soil the colour of effluent is substantially reduced. The degree of this reduction depends upon soil characteristics; clay containing solids have the greatest colour absorption capacity. BOD reduction generally exceeds 90% indicating that a high degree of microbial oxidation of the biodegradable

(Continued on page 347)

SCIENCE IN INDUSTRY

Particle boards from agricultural wastes

IT is possible to prepare particle boards from some agricultural wastes. The process of making boards from cotton-stalk and similar other agro-wastes can be exploited by farmers on co-operative basis.

Particle boards

A particle board can be defined as: "a sheet material (board) manufactured from small pieces of wood and/or other ligno-cellulosic materials (e.g.,chips, flakes, splinters, strands, shives etc.) agglomerated by use of a synthetic resin and/or other organic binder together with one of the following agents: heat, pressure, moisture, a catalyst etc."

The particle boards may be classified as (i) Platen pressed boards,and (ii) Extruded boards. The first type of boards is obtained by pressing the board material in a heated platen press. It is the most common method. The second type of boards are obtained by extrusion of the material in a continuous length from between parellel metal platens.

Agricultural wastes as raw materials

Various plant species and varieties are cultivated for their economic utility; however, many plant parts do not find economic utility. For example, in a cotton plant, while lint and seeds are put to use, the rest is wasted as fuel or thrown in manure pit. In paddy, husk is available as waste from rice mills. Likewise, almost in every cultivated plant there are several parts going waste. Most of these plant parts contain valuable cellulosic materials or fibres which could be used for making particle boards. It has already been established that particle boards can be prepared from agricultural wastes such as cotton stalks, paddy husk, groundnut husk, bagasse, stalks of cereals and pulses, saw dust, etc. By finding proper use for such farm wastes, we can reduce cutting down of natural forests, increase economic returns from farm lands and generate employment potential for the rural unemployed.

Manufacturing processes

Fig. 1 shows the flow diagram of flat press method of particle board production. The different processes are described in short:

(i) *Chopping*: The raw material is chopped into small bits by chopper having rotar blades and one adjustable stationary blade.

(ii) *Pulverising*: The small chips or particles are further reduced to a fine size through a hammer mill which reduces them by impact until they are of a size required to pass through perforated plates or slotted screens. The type of machine and size and shape of perforations will be chosen to suit the type of particle and also the desired final size and geometry. Continuous and rapid flow of particles through these mills is enforced by a regulated stream of air. Because of the small diameter of cotton stalk and similar materials, milling requires less power than in case of wood. Also, milling is easier and board making is less expensive.

(iii) *Drying and screening*: Before pressing the particles into boards, it is necessary to dry them to correct moisture content. The drying apparatus must be flexible to fit the pattern of a particular process. Some methods convey a continuous mass of particles mechanically through a chamber heated to a temperature of 100°C-150°C. Other methods working at temperatures upto 350°C keep the particles in suspension for the drying period. Whatever the method used, the aim is to dry particles of varying sizes to uniform moisture content quickly and economically. Oversize particles are removed by a vibrating screen with a mesh or slotted holes after drying.

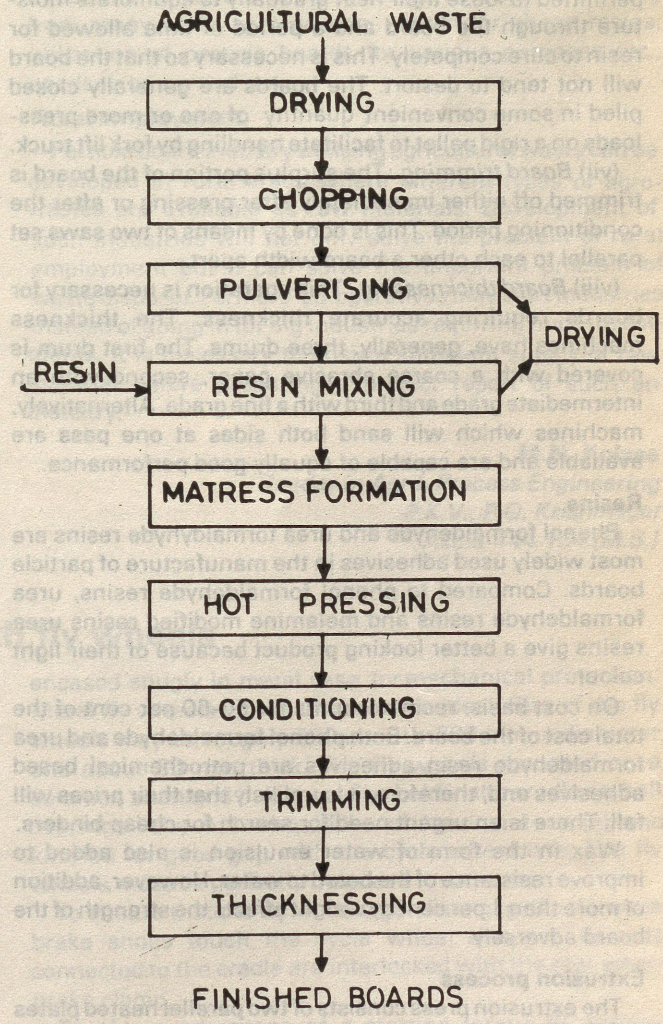

Fig. 1. Particle boards from agricultural waste

(iv) *Glue coating or particles :* Mixing or blending of the resin binder with particles is aimed at applying a thin film of resin, though not necessarily a complete coating, to each and every particle so that, in the eventual close binding of the mass, each is effectively spot welded to its neighbour.

A common method is to feed the batch of particles into a revolving drum and spray the necessary quantity of resin into it. As the drum revolves contact of particles with each other helps to ensure even distribution of resin. As an alternative, rotating arms or paddles inside the drum can maintain movement of the particles.

(v) *Board forming :* The particles are metered out, with their weight or volume predetermined according to the desired board thickness and density, to form a mattress. Thickness of this mattress may be some three or four times the thinkness of the finished board. The mat is then hot pressed in an electrically heated hydraulic press at a pressure of 18-22 kg/cm^2. It is higher for multiplaten presses (25-30 kg/cm^2). The press is kept closed for 12-15 minuties at a temperature of 115^{0}C-150^{0}C depending upon the thickness of board and raw materials used.

(vi) *Board conditioning :* The hot pressed boards are permitted to loose their heat gradually to equilibrate moisture through the board and a period of time allowed for resin to cure competely. This is necessary so that the board will not tend to destort. The boards are generally closed piled in some convenient quantity of one or more press-loads on a rigid pallet to facilitate handling by fork lift truck.

(vii) *Board trimming :* The surplus portion of the board is trimmed off either immediately after pressing or after the conditioning period. This is done by means of two saws set parallel to each other a board width apart.

(viii) *Board thicknessing :* This operation is necessary for boards requiring accurate thickness. The thickness machines have, generally, three drums. The first drum is covered with a coarse abrasive paper, second with an intermediate grade and third with a fine grade. Alternatively, machines which will sand both sides at one pass are available and are capable of equally good performance.

Resins

Phenol formaldehyde and urea formaldyhyde resins are most widely used adhesives in the manufacture of particle boards. Compared to phenol formaldehyde resins, urea formaldehyde resins and melamine modified resins urea resins give a better looking product because of their light colour.

On cost basis, resin accounts for 50-60 per cent of the total cost of the board. Both phenol formaldehyde and urea formaldehyde resin adhesives are petrochemical based adhesives and, therefore, it is unlikely that their prices will fall. There is an urgent need for search for cheap binders.

Wax in the form of water emulsion is also added to improve resistance of the board to water. However, addition of more than 1 per cent by weight affects the strength of the board adversely.

Extrusion process

The extrusion press consists of two parellel heated plates arranged to form an orifice rectangular in shape. This orifice is equal in one dimension to the width of the board, and the distance between the plates can be adjusted to give the required board thickness. Particles are fed at one end of

Table 1. Characteristics of wood particle boards

Characteristics	*P.F. single layered board, grade A*	*P.F. single layered board, grade B*
Bulk density, kg/m^3	750	800
Moisture content, %	8.7	7.1
Modulus of rupture, kg/cm^2	122	189
Modulus of elasticity, kg/cm^2	20.1	28.3
Tensile strength, kg/cm^2	11.0	11.6
Water soaking behaviour		
a) Vertical soakings:		
Water absorption, % (24 Hrs)	36.0	15.4
Thickness swelling, % (24 Hrs)	10.2	5.1
b) Horizontal soaking:		
Water absorption, % (24 Hrs)	23.9	6.2
Thickness swelling, % (24 Hrs)	4.8	2.8
Nail holding strength, kg	6.0	110
Screw holding strength, kg	175.0	362

(*Reference :* Singh, S.M. Wood particle board—Its applications and performance in buildings, Res. and Industry, Vol. 25, December, 1980 page 191-197)

Table 2. Characteristics of particle boards made from cotton plant stalks

**Resin content %*	*Density kg/m^3*	*Moisture content, % before pressing*	*Moisture content, % after pressing*	*Tensile strength kg/cm^2*	*Modulus of rupture, kg/cm^2*
3.7	570	10.0	6.0	5.8	15.5
6.5	610	10.0	6.0	15.4	21.2
12.2	670	10.0	6.0	22.8	35.0
14.6	690	10.0	4.0	27.0	43.5
20.8	720	10.0	3.0	27.3	66.7

*Resin—Urea formaldehyde

(*Reference:* Pandey, S.N. and Mehta, A.K. Particle boards from cotton stalks, Res. and Industry, Vol. 25, No. 2, June, 1980, page-67)

Table 3. Characteristics of particle boards made from sugar-cane bagasse

Thickness, mm	16
Density, kg/m^3	639
Bending strength, kg/cm^3	199
Internal bond, kg/cm^2	8.2
Swelling after 2 hrs, %	2.2
Swelling after 24 hrs, %	5.8
Water absorption (2 hrs), %	9.0
Water absorption (24 hrs), %	25.5

(*Reference:* Paturau, J.M. Byproducts of the cane sugar industry, Vol. 3, Publisher—Elesevier Scientific Publishing Co., New York, 1982 page-109-119).

the opening and forced between the heated plates by a reciprocating ram. Orientation of particles tends to be perpendicular to the plane of the board in contrast to platen pressed boards where orientation is primarily in the plane of the board. The bending strength of extruded boards is less than that produced by platen press method.

Testing of particle boards

The introduction of a new material eventually brings with it the need for the measurement of its strength and physical properties. The properties of a particle board may be classified under three headings:

1. Physical properties,
2. Strength properties, and
3. Working properties.

1. *Physical properties*—Under this heading, properties to be tested are density, moisture content, water absorption, stability, thermal conductivity, fire resistance and resistance to insect and fungal attack.

2. *Strength properties* — The following properties are normally studied as strength properties: bending strength, deflection under sustained load, tensile strength, shear strength, compressive strength, impact resistance and screw holding resistance.

3. *Working properties* — They include accuracy to size, surface quality and machining property.

Tables 1 to 3 show some properties of the wood, cotton stalk and bagasse particle boards.

Uses of particle boards

A variety of particle boards can be prepared from cotton stalk and other similar agricultural wastes depending upon the use to which they are to be put. Such particle boards can be used for general purposes such as in covering and ceiling for decoration and in furniture for table tops and drawer bottoms. Particle boards with lower density can be used for insulation purposes. Particle boards with higher density can be used for making some tools, jigs and other fixtures, rubber press dies, drawing and piercing tools in automobiles and general engineering industries. Boards of higher strength can also be prepared by three layers with coarse particles kept in middle and fine particles on both sides. Depending upon other uses, boards can be overlaid with metal or plastic sheets also.

Moulded particle boards have a broad range of potential uses such as car instrument panels, TV cabinets, suitcases, table tops, trays, containers, etc. One West German firm has developed the production of cement boards which can be used for exterior walls, roofing etc. The raw material to produce I m^3 of such cement board are: 730 kg of portland cement, 270 kg of bone dry wood flakes, 30 kg of chemicals (minerals) and 300 kg of water. The plant of 50 m^3/day capacity utilizes wood but tests with bagasse have proved satisfactorily.

Research gaps

Some research work has been carried out on particle board making at the leading research institutes like Central Forest Research Institute, Dehra Dun; Regional Research Laboratory, Jorhat; Central Building Research Institute, Roorkee; Regional Research Laboratory, Jammu; Cotton Technological Research Institute, Bombay, etc. However, more efforts are needed to apply the technologies at commercial level. Further work on development of economical and suitable processes for particle boards making from many other agro-wastes, search for cheap resins, utilization of particle boards for various purposes etc., needs to be carried out.

Rural employment

Particle board industry utilising agricultural waste can be developed in rural areas where different types of agro-wastes are available as raw materials. Development of such industries will not only solve the problem of rural employment but it can solve the important problem of waste disposal. Farmers' co-operatives may start industries instead of going in for big industries requiring huge investments. It is necessary to ensure sufficient supply of raw material before preparing a project report of such an industry.

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Bicycle with fly wheels

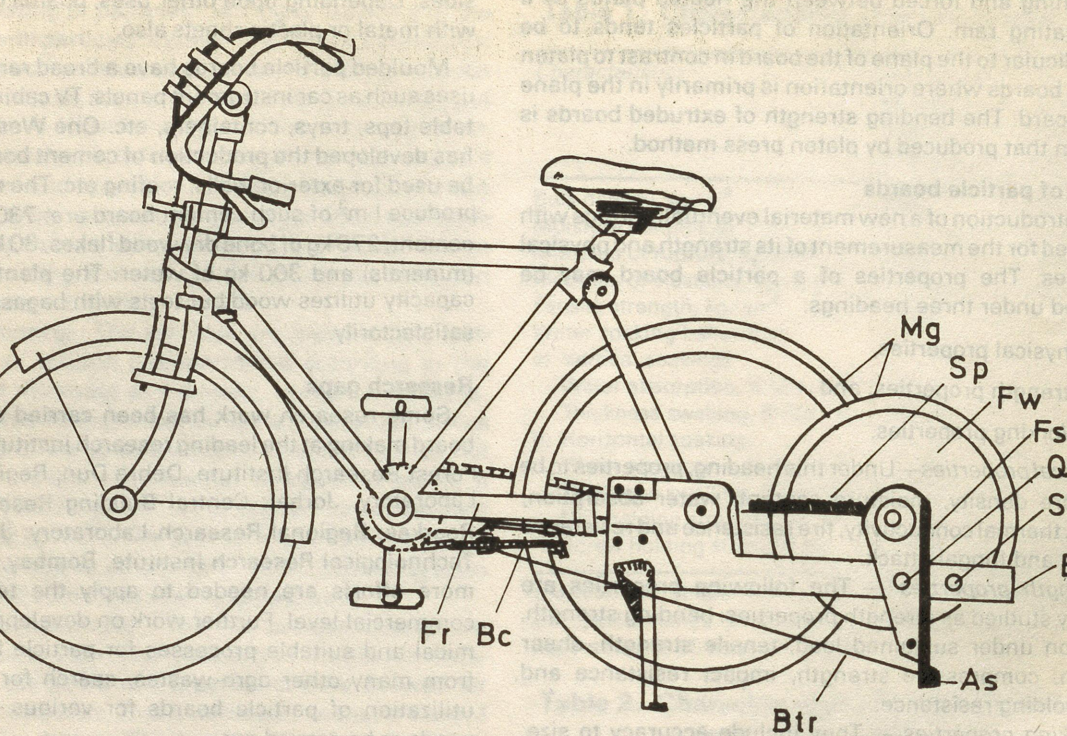
THE author proposes here provision of two fly wheels which may be engaged to or disengaged from the rear wheel of a bicycle at will as shown in the sketch for better energy utilization to the ease of the rider, to make the bicycle more efficient.

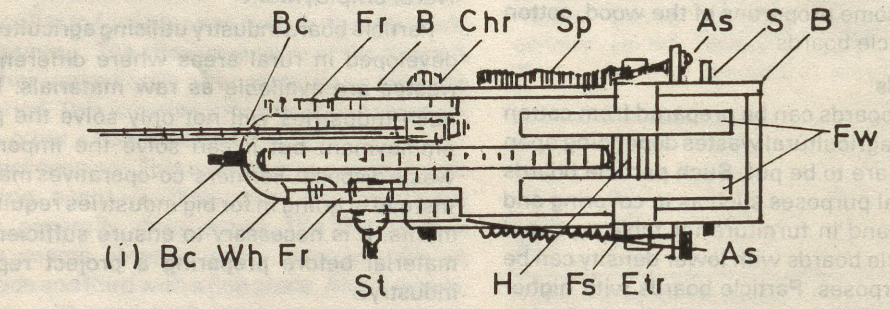
When the cycle is moving along an even and horizontal road or down slopes, the fly wheels gather energy which will be released to cross raised road surfaces, or crests of wavy roads without loss of speed or demanding extra effort from the driver who can also take intermittent rest.

The fly wheels may be of the size of double ended grinder (but not so wide apart) and can be easily made of clay at the potters' wheel (to be cheap) then burnt to harden up and encased snugly in metal case for mechanical protection. Metal fly wheels would of course be ideal. Size of the fly wheels may be roughly 250 mm to 300 mm in diameter and about 30 mm thick. The fly wheels mounted on a common shaft and hub should be held in the cradle on ball bearings—the hub should be of hard material(s) and knurled for good grip with the cycle wheel tyre. The fly wheels must be perfectly balanced in any case.

To ensure that the fly wheels get disengaged before the brake shoes touch the cycle wheel rim, two tie-rods connected to the cradle are interlocked with the rear wheel brake clamp.

To obtain advantage of a starting torque (if desired)





Mg-Mud guards, Fw-Fly wheels, Fs-Fly wheel support, S-stop, a-Pivot(s) of fly wheels support, B-bracket, As-Adjustment screw, Fr-frame, Chr-chain on ratchet wheel, Sp-spring, Wh-wheel, St-stand, H-Fly wheel engagement hub, Btr-fly wheel OFF & brake ON interlooking tie rod, Bc-brake clamp, (i) interlock

rider should hold the cycle on its stand (to raise it above ground) and pedal, then apply the brake, ride on the cycle and then release the brake.

The wheels of the bicycle should be fully inflated for best results.

Fly wheels can similarly be applied to cycle rickshaws.

Upendra Kumar Das
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TECHNOLOGY FOR VILLAGES

Smoke-free efficient domestic ovens and a quick solid ignitor

TWO designs of double chamber oven, capable of burning cheap and easily available coal, etc., in clean and efficient manner have been developed (and patented) at Central Fuel Res. Institute (CRFI), These designs enable removal of volatile matter from raw coal (1.8 kg) in an outer chamber. The inner chamber containing the devolatilised coal (obtained from a previous run) burns practically in a smokeless manner and efficiently providing heat for cooking. The coal volatiles released from the outer chamber can either be burnt separately in a gas stove or injected into the central coke-fired chamber through suitable pipe connections to provide additional heat for cooking.

In order to facilitate quick ignition of the solid fuels, and to get rid of the undesirable smoke from conventional ignitors like cowdung coke, kerosene, wood, agro-wastes, etc., the use of an efficient smokeless ignitor is felt everywhere. CFRI has developed a solid ignitor from saw-dust as the main ingredient for initial lighting up of fuel in domestic ovens. With this ignitor, cooking can be started earlier than possible with conventional ignitors. The cost of two pieces of such ignitor, weighing about 90 and sufficient to light up one charge, is only 50 paise approximately.

A suitable attachment, called the V.M. burner, developed at CFRI and patent applied for, can be utilised in conjunction with conventional smokeless combustion of raw coal. Heat utilisation efficiency increases from about 19% to 26%-28%, the higher figure being obtained when CFRI developed ignitor is also used.

The efficiency of the ordinary oven using this ignitor and also using a V.M. burner attachment is about 30% when semi-coke from low temperature carbonisation of coal is used as the fuel. The thermal efficiency of this oven without the attachment and ignitor is about 27%.

Among the several advantages of the new ignitor and V.M. burner in ordinary ovens and improved oven are:

(i) Direct use of coal without smoke pollution hazards:

(ii) No wasteful combustion. The volatile matter (in coal) which is otherwise released in the atmosphere and goes waste is gainfully utilized;

(iii) No long wait for starting the cooking, as cooking can be started shortly after the lighting of the ignitor.

Interested entrepreneurs may contact the Director, Central Fuel Research Institute, P.O. FRI, Dhanbad-828108.

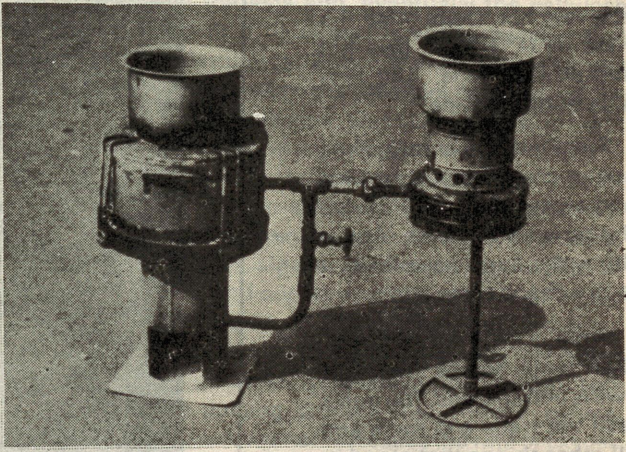


Fig. 1. Double chamber oven coupled to gas stove

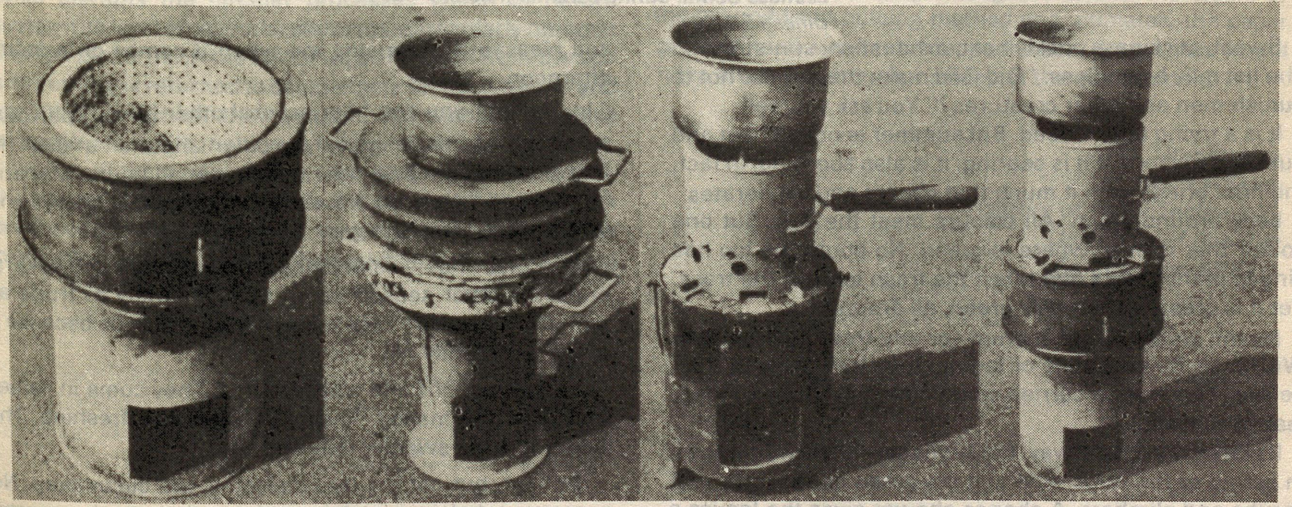


Fig. 2. *(Left to right)*. Improved portable oven, double chamber oven with gas circulation system, conventional portable oven with V.M. Burner, improved portable oven with V.M. Burner

ON LEAVES AND FEATHERS

The summer scene

MID-morning. Already the wind is hot. By noon it comes like a furnace blast. And while it blows, the plants droop, dogs pant and men feel lazy and dozy.

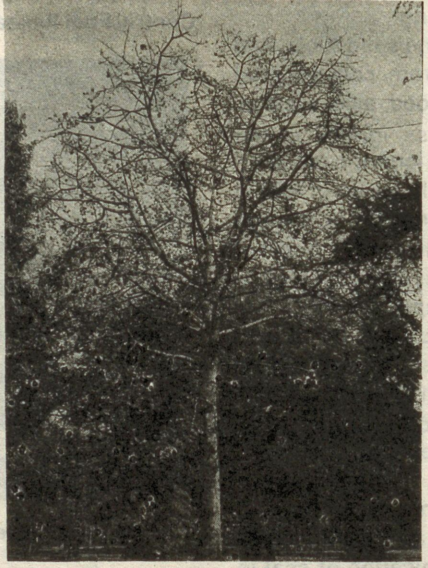
"Awful weather!" says everybody. And you will hear its echo for weeks together. For the hot, mostly dry, summer is our longest season. It usurps many days of the spring, and also of the rains.

After the monsoon the days are once again hot and dry. In September and at least half of October people still talk of summer.

For the present take just May and June. The two months are enough to test your patience. They are not merely hot, very hot. Quite often the wind halts. Then it gets hot and stuffy inside. And it is little better outside.

Suddenly power fails. Fans and air-coolers stop. You sweat and swear but can't restart the fans and coolers. And if the water supply also fails, it is like chaos come again.

What is that? A dust storm. Dust seeps across the sky. It swirls and spreads. The gusts lash the trees and roofs and all other things that stand in their way. People run about in utter confusion.



Leafless Semul during summer *(Photo: Dinesh Sinha)*

Sweat, stickiness prickly heat, exhaustion, sun-stroke.... The list may be endless. "Did God make the days so hot to punish men and other creatures?" You ask yourself.

It is a trying time indeed. But summer is not all heat and dust and horrors. If it is searing, it is also soothing. In fact, the heat brings with it much that cheers and exhilerates.

Look around again. All colours meet the eye. But one colour that is everywhere is green. No doubt the loo has singed many plants and taken the fresh look off the trees. Yet it is green, generously green, all around.

Neem, shisham, gul mohur—or any tree, all are green. With their flowers gone or fading, they look greener than before. The mango carries some new pinkish or coppery leaves as well.

If watered the right way, the lawns stay lush and green as in spring or the rains. Add to it the green of the vines and shrubs and climbers. A chance shower gives the leaves a laundered look.

But for this green the summer would be far more harsh and glaring. And without the shade of the leafy trees, a lot more uncomfortable too.

At sunset the hot, gritty wind stops. As though a malignant force has spent itself out, everything stirs and perks up. The flowers raise their drooping heads. The grass looks greener.

The hot May, and also the hotter June, nurse many flowers. Jasmines, for example. One of the varieties blooms at night. It spreads its heady scent far and wide. Keora, khus and sandalwood paste perfume the air in their own ways.

Where does the koel sing? Poets tell us that the bird calls in a mango grove under a cloudy sky. In reality it is not always so.

You may hear the koel's voice from any tree. And at any time—morning, afternoon, evening, even night—clouds or no clouds. The bird feels as much home in a town's road-side trees as in the countryside.

Trees attract many birds, among them the koel. You may not spot it, but you cannot miss its coo-oo. It is so sweet, and pleasantly surprising too when it comes on a sultry afternoon.

In summer you can hear several other birds. Sparrows sing their chorus religiously at dawn and then at dusk. In between they keep up their chitchat at all hours. Mynahs chatter and doves coo. Now and then a bulbul appears and utters more musical notes.

Also pleasing — sometimes amusing are the hawkers' cries. No other season offers such a variety of fruits as summer. If you don't see enough fruit, it may be because it is not sufficiently hot.

Look — melons and watermelons! They come in sallies and flood the market. Their very sight is refreshing. The hotter it is the sweeter they are.

Smaller, but not the less welcome, are cucumbers No summer salad is complete without their cool, crunchy slices.

A more liberal summmer gift is the mango. Aren't there about 300 varieties of the fruit? It is everybody's favourite. No wonder it is grown in every corner of India. Coming in spring (from the South) it lasts till August, even after.

Litchis, falsas, cherries, apricots, plums — these are some of the other joys of summer.

We always talk of eating fruits. So we forget that we also drink it. Squashes are made from fruit pulp — lemon, orange, mango, pineapple. More varied are the ingredients of sherbets. They use not only more fruits but also certain flowers and herbs and seeds.

For more fun you may try some mango milkshake or banana split. If you'd rather have juice, there are many to choose from — watermelon, mango, orange, litchi, guava, pineapple.

Long ago King Bhoja saw a moral in the season's bounty. "O! Lord of Creation", he said, "the creation of all these will be vain if there is no summer."

Chant these words when the heat harasses you. Your summer will certainly be more delightful.

O.P.Bhagat
New Delhi

ENVIRONMENT *(Continued from page 340)*

waste constituents takes place on percolation through the soil with outfall pipes. Untreated effluent is carried in another direction for disposal, either out into rivers to areas of rapid flow or tide or down into the bottom of large rivers. Holes called diffusers spaced along the end of the pipe allow the effluent disposal over a relatively wide area rather than pouring it out in the concentrated stream.

Economics of waste treatment

The most economical approach is to cut down water pollution and waste treatment expenditure and to minimise the quantity of water usage in pulp and paper making, which means maximum water recycling and minimum pollution load on treatment system. In fact, effort should be made to achieve zero effluent discharge through inplant measures to avoid installation of expensive effluent treatment plants.

Pulp and paper industry vis-a-vis ecosystem

To know the ecological impact of paper industry, one has to know that for the manufacture of pulp and paper, the mill removes from the soil a major constituent of the soil ecosystem. A harshly logged mountain side, lacking the soil-binding tree roots, may erode rapidly, so that the soil system loses much of its biological capability. Even if logging is sound, the soil system may nevertheless be stressed, for the mere removal of the logs from the soil cycle disrupts the circular processes which in nature sustain the level of essential elements, particularly nitrogen and phosphorus in the soil. If logs are taken from the soil and nothing is returned to compensate for the nitrogen and phosphorus which they contain, the amount of these essential elements in the soil will inevitably decline.

The pulp and paper products and cellulose which they contain are removed from the ecological cycle which produced them, and to which, they must be returned if the cycle is to remain in balance. However, in principle, nothing prevents the ultimate return of the cellulose to the soil cycle. Cellulose in most paper products remains accessible to the attack of soil microorganisms and could readily be reintroduced into the soil system. It follows that, in principle at least, a paper industry which converts tree' cellulose into paper products need not seriously disrupt the ecosystem, so long as the soil is properly sustained and unused organic matter in the logs and eventually the cellulose itself, is returned to it. It is sometimes suggested that restoration of soil fertility can be accomplished by returning the missing chemical elements themselves to the soil in the form of inorganic fertilizers. This is not necessarily the case, for unless the organic content of the soil is maintained, the efficiency of nutrient uptake by the plant root may decline, so that nutrients leach from the solid into surface waters which then become polluted. In groundwood pulping, which simply breaks up the wood by mechanical means and converts nearly all of it into pulp without the intervention of chemicals, has a minimal impact on the environment. The only negative effect is due to the misplaced "disposal" of waste organic matter from the ground-wood pulping process into surface waters. Here the added organic matter increases the rate of oxygen utilization by the bacteria of decay which may become so rapid as to threaten the latter with asphyxiation thus disrupting self-purifying ecological cycle. If the waste of the groundwood pulping method and ultimately the paper product itself were returned to the soil, the process would have almost no harmful effect on the environment.

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BOOK-REVIEWS

J.C.BOSE SPEAKS Edited *by* Dibakar Sen and Ajoy Kumar Chakraborty, *Puthipatra*, 9. Antony Bagan Lane, Calcutta 700009, Pp. 456, Rs 75.

SO rapid has been the advancement of scientific learning during the past hundred years that many 'miracles' of yester-years have become commonplace things of today. The name and fame of many great inventors and scientific investigators have faded into obscurity even during their lifetimes. It is no wonder, therefore, that Sir. J.C. Bose, whose startling discoveries took the European scientists by storm just seven decades ago, should be forgotten by the present generation. Students of plant physiology remember him only as the inventor of the crescograph, a remarkable instrument which could magnify the pulsation of plants a hundred million times, or the phytograph which recorded plants' responses automatically. While in today's electronic age these may look trivial, at the time. Bose invented and built them these instruments were considered marvels of human ingenuity. As early as 1895, Bose had designed and built, before any European could do it, the first practical instrument that could receive radiowaves of short wavelength which could then be used to perform work by remote control. But he never patented his invention.

Not many of our present generation know that Bose was not merely a scientist but also a great philosopher with a cosmic vision, a poet who wrote in prose, and an ardent patriot who derived all his guiding inspiration from his native soil. The book under review brings out many of these unknown facets of this great man's personality through his own writings. The speeches, articles and letters, many of them never published before, are arranged in a chronological order to provide the reader a glimpse of one of the darkest periods of India's spiritual degeneration, when our educated countrymen spent their life in slavish imitation of the West—when even learned men of science had to depend on the condescending patronages of their European counterparts.

Bose's writings and speeches also bring out the portrait of a geat Indian whose spirit of deep scientific inquiry, whose profound love of universal humanity and whose serene optimism had been a source of inspiration to all who had come near him. Unlike the Western scientists, who in their excessive specialisation often lost sight of the fact that there are not many sciences but one science that includes all, Bose's synthetic mind could discern an underlying unity amidst the appalling diversities of this physical universe.

One may as well read the book as a spiritual autobiography of a man who had devoted himself wholeheartedly to the cause of science—the story of his uphill journey through all the vicissitudes of fortune, and the ultimate fulfilment of his dreams. Diligence and perseverence were the secret of his success. Through his life's ordeals he developed a moral strength which no earthly adversity could ever destroy.

One must commend the editors for the hard work they have put in to collect all of Bose's speeches and writings, many of them unpublished, into a single volume which, for its sheer informative content, must find a place on the bookshelf of every discriminating reader.

S.C. Bhattacharya

THE QUANTUM WORLD *by* J.C. Polkinghorne, *Penguin Books* (Available with: *Penguin Overseas Ltd.*, 706, Eros Apartment, 56, Nehru Place, New Delhi-110019), Pp. 100, £2.95

QUANTUM physics is one of the great achievements of the present century. That energy is transmitted or absorbed in form of minute packets "quanta" instead of in a continuous manner has brought in a revolution in physics. For, what is physics but a play of energy? This quantum revolution, which has given a totally new picture of the micro-world, has overwhelmed the previous what is known as "Classical or Newtonian" physics. The latter is now accepted to be effective only at the macro-level of the world. It has shown, once for all, that nature does not reveal its secrets as easily as it was once believed. Even today after about 80 years of research, the subject continues to contain hotly debated issues. The reason is that these issues give a variety of solutions allowing a physicist to interpret them as he thinks best. So, one can easily imagine what a layman could think about this subject. In fact, he does not know about this important subject, let alone thinks about it. Even those few who have tried their hand at it have given it up in exasperated feeling confused and beyond their intellect. The book under review, as the author claims, is written with these latter persons in mind. However, it is difficult to say whether he is successful, because it depends to a large extent upon the perseverance, intellectual background and concentration power of the reader. If he is lacking in any one of these qualities, he is bound to find this book a hard nut to crack. But at the same time, the book would prove to be great value to our students of postgraduate classes, who are given lectures less on conceptual understanding of the subject and more on mathematical derivations. The book would make the concepts in the subject clear and easy-to-understand.

The book begins with the history of the subject, goes over to the crucial principle of superposition, discusses the basic tools needed to test the theory, and finally gives the debatable issues in the subject. The beauty of the book lies in its three features: it gives within 82 pages a glimpse of the important ideas and pitfalls in the subject, and some interesting anecdotes about those physicists who laid the foundation of the subject, and is written with a touch of humour. At the end of the book an appendix on the mathematical formulations of the subject and a glossary of technical terms have been included. The book, though written lucidly and clearly, should have been a longer one, giving numerous parallel situations in day-to-day life for the reader to assimilate a new idea firmly before another one is introduced if its primary purpose was to bring quantum mechanics down to the level of a layman. The book somehow races through the subject assuming things unknown to a layman. Nevertheless, it is an excellent effort, at least for graduate and post-graduate students of physics and chemistry.

Dilip M. Salwi

ACQUIRED IMMUNODEFICIENCY SYNDROME, AIDS
Edited *by* R.N. Basu, D. Chattopadhyay and Arvind Rai, *National Institute of Communicable Diseases,* 22 Sham Nath Marg, Delhi 110005. Pp. 52.

THE emergence of AIDS, which has a mortality rate of nearly 80%, has caused worldwide concern not only in the medical circles but also among the general public. Although officially recognised for the first time in 1981, more than 19,550 cases have been reported so far of which nearly 80% are from the US alone. Till date only a few cases have been reported from the Asian countries. Although no case of AIDS has so far been reported from India, the possibility of its entry into the country in future cannot be ruled out in view of the tourist traffic from the affected countries.

Keeping in view this exigency it is imperative that medical personnel in the country are well equipped to face the challenge if the need arises. For that it is necessary to provide the relevant information to the various categories of health personnel. For instance, physicians should be familiar with the clinical features of the disease while laboratory scientists would need to learn to perform the necessary tests for diagnosis. Public health workers on the other hand should understand the mode of transmission and the associated risk of infection so that they can educate the community.

The booklet under review has been brought out primarily with the objective of meeting the above requirements. It brings out the technical aspects in a simple language so that even a non-specialist health worker can learn how to recognize the basic features of the disease in an individual and take necessary control measures. Besides discussing the epidemiology, virology and immunopathogenesis of AIDS, the book devotes a full chapter to laboratory diagnosis which gives detailed tests including isolation of the AIDS virus and serodiagnosis. There is also a chapter on "Strategies for Control" which sets out guideline procedures to prevent spread of the virus through blood transfusion, and other routes.

B.B.

1984 : SPRING—A choice of futures *by* Arthur C. Clarke, *Panther,* (Available with : *Rupa & Co,* 3831, Pataudi House Road, Daryaganj, New Delhi-110 002), Pp. 268, Rs. 45.50

ARTHUR C. Clarke is one of those few Science Fiction and science writers alive who have seen the development of space technology and science fiction literature from the initial stages. He has seen those days when science travel was looked upon with amusement and scepticism and science fiction was considered to be nothing but kidstuff. In those pre-Space Age days, when speculations about space travel were a good pastime, he wrote about them not only in form of facts but also in form of stimulating fictions. He himself also contributed some important ideas (for example, global communications through three geostationary satellites) to the welter of speculations. Some of his ideas have now come true and as a result he is sometimes also referred to as a prophet of Space Age. The strong point of his writings is that his science is thorough and his fiction, a projection of science into the near future, is plausible and realistic, apart from being entertaining and interesting. Besides, he is a keen scuba diver because he considers sea a frontier and challenge to the ingenuity of man, like his old love space. There is therefore not a more competent person than he who could talk at length on space, science fiction and sea.

The book under review is a compilation of his talks, lectures, essays and forewords on the aforementioned subjects which he had given or written from time to time. The title of the book has hardly any significance except to mark a year which, according to George Orwell, was to be a world that believed in such slogans as "War is peace", "Ignorance is strength", etc. Clarke however shows through his various pieces given in the book that the world has fortunately not turned out to be so, thanks to the advancements mainly in space technology. Moreover, by adding the suffix "Spring" he has given an optimistic tone to the title. The overall effect, and even the purpose, of the book is however not so-in fact, cannot be so-because it is after all a compiled work and not a book written with this aim in mind. Nevertheless, the book is interesting and educative interspersed with Clarke's terrific sense of humour which only he could blend with the serious subjects of space and seas.

To give an idea about the book, its contents are clearly demarcated into four parts, namely, the weapons of peace, Apollo and after, the literary scene and from the coast of coral. In the first part Clarke discusses at length the future possibilities of communication satellites, computers and electronic gadgetry. He has also mentioned problems of a developing country trying to adopt space technology and also of a world on the brink of a nuclear war. The second part is exclusively devoted to spaceflights, his own predictions which have come true and future possibilities of space travel. One interesting article in this part is about how far correct science is presented in science fictions and the kind of traps science fiction writers often fall into while writing space fictions. The part dealing with literature is a mixed affair in the sense not all the pieces a reader would appreciate because he or she would not know the background of the persons being discussed in some of them. The last part appealed to this reviewer most for the simple reason that he knew so much little about seas and diving.

All in all, the book is both educative and entertaining. For those who have read most of the previous essays on space by Clarke, as this reviewer has done, the book has not much new to offer. Otherwise, Clarke's writings are as interesting as they always have been.

Dilip M. Salwi

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AN INTRODUCTION TO PRACTICAL MICRO-ELECTRONICS *By* Robert Howlett, TEC/Hutchinson Book (Available with: *B.I. Publications,* Promotion Department, 61-63 Lakshmi Building, Sir Phirozshah Mehta Road, Bombay-400 001) Pp. 201, £ 5.95.

THIS is one of the series of seven processors published by Hutchinson. It contains practical exercises in microelectronic systems. The exercises are based on the HEKTOR micro-processor evaluation system produced by the Open University, Great Britain. The HEKTOR microcomputer is a development and evaluation kit. It is designed for use in writing short-to-medium programs for control applications although its real purpose is as an educational aid.

The book under review presents a comprehensive treatment of the subject. It contains five chapters with a large number of functional exercises. The first chapter describes component parts of microcomputer system and looks at each element of the HEKTOR microcomputer in turn. The second chapter introduces the idea of memory address, microprocessor register and commands. Chapter 3 explains the way of writing microprocessor programs using standard mnemonics adopted in 8085 and Z80. In the following chapters more complex programs, loops and branches, input/output, subroutines and interrupts have been dealt with. It also contains a number of exercises without solution. These exercises may be suitable for adoption to student projects. Five appendices at the end of the book incorporating summary of 8085 instruction set and data sheet for 8185 support chip are quite useful. Solutions to numerous exercises spread over the book make it a practical handbook on microelectronics. However, the book is intended to be used with the other books in this series.

On the whole, the book meets the objective of providing an introduction to practical microelectronics. It will prove useful to both students and technicians concerned with the design, manufacture and servicing aspects of microprocessor-based systems.

B.D. Prasad

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APPLIED MATHEMATICS FOR ADVANCED LEVEL *By* W.E. Williams and A. Waltham, *Hodder and Stoughton* (Available with: *B.I Publications Private Ltd.,* 61-63, Lakshmi Building, 4th Floor, Sir Phirozshah Mehta Road, Bombay-400 001) Pp 345 £ 6.95.

THE book under review basically covers various topics in mechanics and as such will be useful to students, especially those studying physics, at the plus two level of the new scheme of education. A large number of examples have been included in each chapter which not only illustrate applications of the underlying physical principles and concepts but also help students in their understanding of these concepts and principles. Also included at the end of each section (in each chapter there are various sections) are a large number of unsolved exercises.

Miscellaneous exercises covering problems from different sections are included too at the end of each chapter. The book has been written in a compact way with clarity of physical concepts. The presentation is lucid and the language simple. It will certainly benefit students at the plus two level. However, the exorbitant price of the book will keep it beyond the reach of a vast majority of Indian students.

P.K. Mukherjee

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DHOOMKETU O HALLEY'R DHOOMKETU *by* Manindra Narayan Lahiri, *Shree Jagadish Chandra Lahiri,* Palasi Hemangini Sarojini Vidyamandir, P.O. Gurap, Distt. Hooghly (W.B.), Pp. 410, Rs. 30.

THIS latest book in Bengali on Halley's comet is among the most comprehensive on the subject published in recent months. The author, who is a keen skywatcher himself, has brought together a wealth of data, both historical and modern, on this legendary comet. In fifteen well written and illustrated chapters, he has covered almost everything one would like to know about comets, and Halley's comet in particular.

He begins with a discussion on comets in general covering the early ideas, common (mis) beliefs and historical accounts of comet sightings in the past. The nature of comets, their structure, orbits and origin and accounts of their discovery and naming are topics covered in much detail in later chapters. Halley's comet itself takes up as many as six chapters in the book which include separate chapters on "Halley's comet 1910" "Halley's comet 1986" and on the various scientific programmes launched to study the comet this time. A couple of chapters in the end are devoted techniques for watching and photographing the comet. Tables and charts given in the appendix provide valuable information about important dates for sighting, details of scientific experiments and the like.

Unfortunately, the book has come a bit too late to be really useful as a comet guide for Halley watching. But with its rich store of information, collected by the author from various sources, the book will be a valuable addition to any amateur astronomer's bookshelf.

Biman Basu

MOLLY ZERO *by* Keith Roberts, *Penguin (Penguin Overseas Ltd,* 706, Eros Apt., 56, Nehru Place, New Delhi-110019), Pp. 251, £ 2.50

MOLLY Zero is a smart, intelligent young woman who was being trained to be a part of the governing Elite. She was being brought up in the Blocks, doing extremely well in all the tests (holograms, computer tests and the like). But like any intelligent youngster of any, age, she wonders as to what lies beyond. She wonders about her own origins and one day wants to break out of the system and look for her father!

It is indeed remarkable that unlike most of today's Scinece Fictions, Keith Roberts does not assume that there is going to be complete uniformity in the kind of government and the life-style of people. History has so far shown us that through the ages, although many dynasties have risen to great heights, there have been great disparities in the life-styles of different sections of society. Keith Roberts seems to have kept this in mind and that is what makes this book interesting reading. Molly Zero's escapades take us through different sections of society two thousand years from now. Even in a hi-tech society, the basic human instincts are going to remain the same. Molly Zero is shown to have the same kind of fascination for the Fair and the Gypsies as any girl of her age today. When she joins them as a showaway in her bid to reach London, she takes great pains to learn their language, respect their customs and their ways although they do not expect much from a white woman like her. There is a chasm between her rationality and what the gypsies think and believe in. Again, we are reminded of the fact that the differences between town and country, between the ruling elite and those being ruled, have remained through the ages and might remain with mankind for as long as mankind survives on this planet.

Again, history has shown us that although the best brains are trained to be a part of the Ruling Elite, it is they who question the validity of things. Revolting is very much a part of being young and Molly too rebels against her fate. No matter what the level of sophistication of technology, it is the ingenuity of the human mind which finds ways of escaping, which finds ways of fooling the sensors and electronics watch dogs. Molly Zero and her boy friend Paul flattered themselves for a long time that they had escaped from the Blocks and had gone from place to place without raising any suspicion. But Big Brother had kept track of all her activities including her involvement with a group of urban terrorists. The Administrators want her back, because she is the last of her kind. The population having stabilised, they had stopped making and raising any more normal babies. They had found Molly to be most intelligent; they had manoeuvred events and tried to teach her party politics but she had failed. She was the new Eve and the State wanted her. Having seen a bit of the world outside, she decides to be very Elite.

Ratnabali Mitra

MOLECULAR SPECTROSCOPY *by* P.S.Sindhu, *Tata McGraw-Hill Co. Ltd.,* New Delhi, 1985. Pp 352. Price not mentioned.

The book under review is perhaps the first comprehensive title written by an Indian in recent years. It essentially caters to the need of undergraduate and post-graduate students of the Indian Universities. It presupposes the knowledge of advanced undergraduate mathematics and quantum mechanics, and the author clearly admits this fact in his preface to the book. Within just three hundred and thirty pages the author has judiciously covered almost all types of spectra falling within the domain of Molecular Spectroscopy. Every chapter has been thoughtfully developed from the first principles to the advanced stage. However, descriptive part is less in the book. Listing of important sources for further reading at the end of each chapter is a useful addition and would prove quite helpful to a serious reader. Similarly, unsolved problems at the end of each chapter would further give a student insights into the subject. However, inclusion of one or two typical solved examples in each chapter would have been desirable. The book would also be of considerable help to the students of biophysics courses in medical institutes and agricultural universities. A more detailed chapter on the history of spectroscopy would have provided a student with deeper insights into the emergence of various spectroscopic techniques and their linkages. Neverthless, the book is a welcome addition.

A.V. Mohan

Books Received

1. **OPERATIONS RESEARCH IN ELECTRICAL SYSTEMS** *by* Anand Khare, *The Indian Seminar & Research Centre,* 307A Mathrusri Apartments, Hyderguda, Hyderabad, Pp. 193, Rs. 85/-
2. **SCIENTIFIC PROGRAMMING USING FORTRAN 77** *by* William M. Turner (Available with : *B.I. Publications Pvt. Ltd.,* Promotion Department, 61-63, Lakshami Building, 4th Floor, Sir Phirozshah Mehta Road, Bombay-400 001), Pp 154, £ 7.95.
3. **GENETICS** *by* Peter J. Russell (Available with : *B.I. Publications Pvt. Ltd.,* Promotion Department, 61-63, Lakshami Building, 4th Floor, Sir Phirozshah Mehta Road, Bombay-400 001), Pp. 896, $ 29.95.
4. **HANDS ON GUIDE TO PC and MS DOS** *by* Alan Hoeing (Available with : *B.I. Publications Pvt. Ltd.,* Promotion Department, 61-63, Lakshami Building, 4th Floor, Sir Phirozshah Mehta Road, Bombay-400 001), Pp. 221, $ 15.95.

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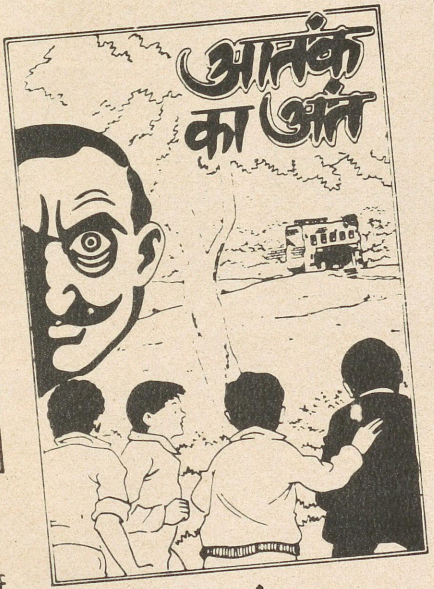
कॉमिक्स आनंद

कॉमिक्स की दुनिया में एक नया नाम

अपराधों का जाल

शार्प के नाम से बड़े से बड़ा अपराधी भी काँपने लगता था. शार्प एक ऐसी मशाल था जिसकी ओर हर अपराधी खिंचा चला आता था. लेकिन क्यों? शार्प ने जिस केस को अपने हाथ में लिया, उसके अपराधी अपने आप को जेल की सलाखों के पीछे पाते थे. कोई नहीं जानता शार्प कब, कहाँ, जिस पर झपट पड़ेगा. जासूस कथाओं का लेखक अचानक जासूस शार्प कैसे बना? जासूसी दुनिया का एक ऐसा चरित्र जिसने अपने बल और बुद्धि के तालमेल से अपना सिक्का जमा लिया. वह असल में कौन है? क्या है चरित्र उसका? ऐसे अनेक रहस्यपूर्ण सवालों का जवाब देती कॉमिक्स आनंद की भेंट – 'अपराधों का जाल'.



आतंक का अंत

वह जालिम था. गरीबों और किसानों को लूटता था. चारों तरफ उसका आतंक था. वह जिधर से निकल जाते लोग दहशत खाकर छिप जाते. कब किसे लूट ले, गोली मार दे कोई नहीं जानता था. लेकिन चार सहासी बच्चों ने उससे टक्कर ली. बुद्धि के सामने बंदूक की एक न चली. आखिर जालिम सिंह का अंत हुआ. साहस और रोमांच से भरपूर – एक रोचक कहानी.

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