

JULY—AUGUST 1989

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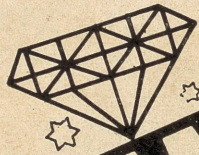
# SCIENCE REPORTER

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From Waste

Mystery Of Bird Migration

The Disappearing Ozone

Gout : A Middle Age Problem



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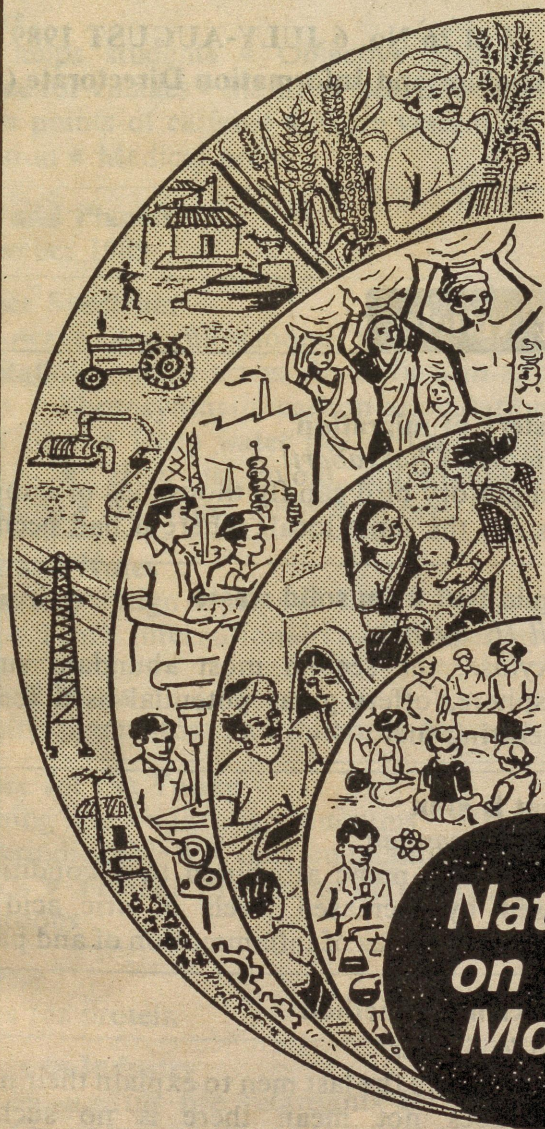
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2715, Darya Ganj, New Delhi-110002.

Rajasthan



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- Extended Green Revolution brings more than threefold increase in food production
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- Better educational opportunities for rural students
- Technology Missions initiated - Science to effectively help the poor
- Package of measures to restore normalcy in Punjab
- Democracy at the grassroots revived - Rejuvenation of Panchayati Raj

***Nation  
on the  
Move***

**FREEDOM - STABILITY - PROGRESS**

davp 89/336



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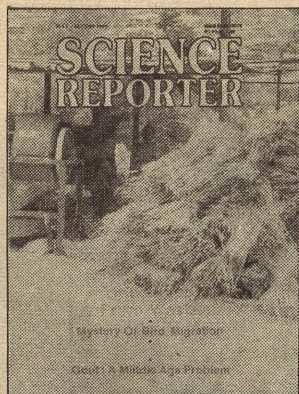
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# SCIENCE REPORTER

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Publications and Information Directorate (CSIR)

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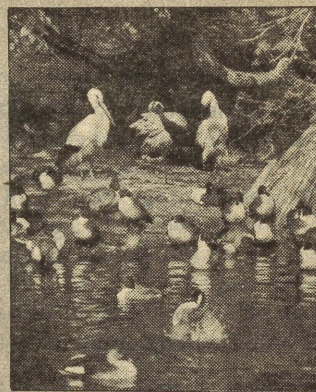
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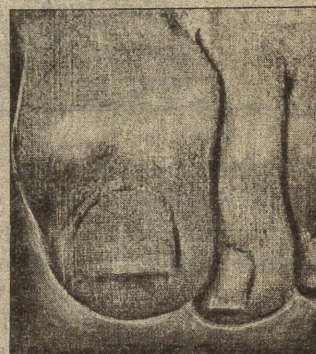
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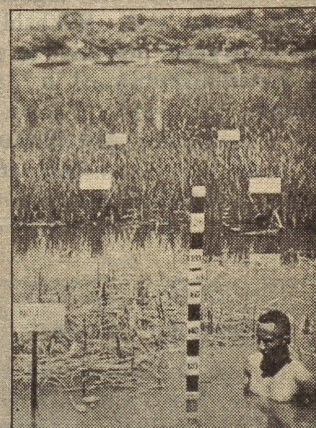
Hugging the Trees • Medicinal Plants and Their Uses • Statistical Mechanics • Basic Biophysics for Biologists • Computers: Systems & Programming • Programming in C • Still River



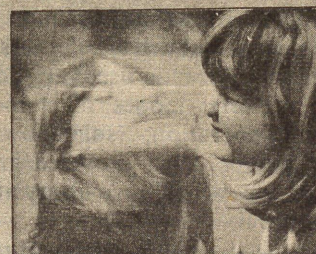
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## LETTERS

### S.R. helps students

Sir, I am indebted to B.N. Singh for his article **Human genetic disorders**. The article being related to the class X Biology course of the C.B.S.E has proved to be a great help to not only myself but all the class X C.B.S.E. students. I hope S.R. will keep on publishing such informative articles and helping students in their studies.

**Manish Lalwani**  
Class X Student  
Hindi High School  
Calcutta-71  
West Bengal

### Objective type questions

Sir, I am a regular reader of S.R. Every topic discussed in it is educative and informative. I suggest you to publish some more "objective type questions", which will help students to take medical/engineering entrance examinations. I think it will also increase the value of the magazine.

I congratulate A.K. Bakhshi for his article **Organic polymers as electronic materials** published in March 1989 issue.

**Md. Ruhullah**  
B.Sc. (Bio.)  
Amrit Science Campus  
Kathmandu, Nepal

### Science for villages

Sir, **Design for household solar stills** by L.V. Maru and S.D. Gorkale (S.R., March 1989) was interesting. It would be useful to those villages near sea and in land where groundwater is saline. I request you to publish more such articles on solar power for domestic use, varieties of solar cookers, modes of domestic power generation, solar-powered water pumps, solar powered grain-heaters, etc. which have utility at the village level.

**N. Mallikarjunam**  
D-13 D.O.S. Colony  
Sullurpeta-524121

### Stainless steels are ideal for utensils

Sir, Recent news items on stainless steel which appeared in some dailies were not totally factual. One of the headlines was "substandard stainless steels could be health hazard", which, with its news content, could lead to scaring away people from buying any stainless steel article. At the same time, there was a great effort to decry the 200-series stainless steels, declaring them unsuitable and inferior for utensils application. The Indian Nickel Development Institute (INiDI) wants to inform the public of the correct situation.

No one would disagree that any substandard article made of any material for that matter, used especially for preparation, storing and serving of food is harmful to varying degrees. Apparently, there are in the market, utensils with nickel polish over mild steel, selling as cheap and "affordable" stainless steel items. Such utensils do pose a health hazard, but not those made with the '200-series' stainless steel developed in India.

The recent news items sought to highlight the virtues of 18% chromium-8% nickel grades (commonly known as 301/304 grades) as ideal for utensils. Undoubtedly, (301/304 grades) are the most preferred material for utensils and large-scale food processing units as they are most hygienic, ensure corrosion-free long life, possess excellent cleanability, do not transfer odour from one batch of food to another, present an aesthetic and pleasing appearance and last for generations. But they need 8% nickel which is expensive.

The price of nickel has shot up in the international market in the last two years. Stainless steel producers in India have started producing what is known as the '200-series' stainless steels which contain 3.5% to 4.5% nickel as compared to 8% in the 301/304 grades, with increased manganese content. These lower nickel-containing 200-series stainless steels are well established grades and are used around the world, including

Japan, for utensils and kitchenware. What has been introduced into the Indian market in the last one year, is therefore no new invention. It is a recognized standard grade of stainless steel, nothing spurious or substandard and hazardous to health.

The 200-series stainless steels are just as corrosion resistant and hygienic and durable as their 300-series counterparts. This is a fact established through numerous corrosion tests in reputed laboratories. Certainly for the utensil and kitchenware applications, they are just as good.

Any stainless steel shop in India would have a magnet, and by usage, the non-magnetic property of stainless steel has been used for ready and easy identification, as the 300-series exhibit almost nil magnetism. In contrast, the 200-series would tend to have some residual magnetism. But exhibiting non-magnetism is no criterion to decide whether a material is stainless (corrosion resistant) steel or not. The only requirement for steel to be stainless is at least 12% chromium content. In fact there are several grades of stainless steels which are fully magnetic and which perform well under certain corrosive environments. For applications such as stainless steel knives, ideally they should be made out of magnetic grades (400-series) with very low nickel content, to retain very high hardness (sharpness) levels and at the same time, be stainless.

Going back to the news items in question, to club the 200-series with nickel-polished mild steel and brand it as a health hazard and poisonous, is unscientific and contrary to the facts. It has only helped creating panic in the minds of the common consumer, who is not expected to be informed at all on the entire family of stainless steels.

**V.R. Subramanian**  
Director  
Indian Nickel Development  
Institute, No. 7  
Shopping Centre  
Block B-6, Safdarjung  
Enclave, New Delhi-110029

## LETTERS

### Plus points of caffeine

Sir, Tanveer Hussain in his article entitled **Caffeine can be dangerous** (S.R., March 1989) has not given the plus points of caffeine. According to Nancy Stedman, the author of *How to Eat for More Energy (Woman's Day, April 15, 1986, New York, U.S.A.)*, caffeine found in tea and colas as well as coffee improves coordination, concentration and alertness. Like carbohydrates, it boosts up a person's stamina in exercise. It also works quickly, sometimes taking as little as five minutes to reach tissues.

The danger of caffeine is in dependency. When heavy users skip a dose they may experience headaches, anxiety, muscle tension and energy dips. Moderation is required. Riska Platt, Director of Nutrition for Executive Health Examiners Group, New York, U.S.A., recommends no more than three cups of coffee a day or four cups of strong tea. Woman who wants to become pregnant must avoid caffeine altogether.

**S.P. Grover**  
*Indian Journal of Physical and  
Natural Sciences*  
3/1 Curzon Road  
Dehra Dun (U.P.)

### II

Sir, This has reference to the article **Caffeine can be dangerous** by Tan-

veer Husain (S.R., March 1989). He has regarded tea and coffee as "common beverages" in the 2nd para of the 1st column. But beverages are the CNS (Central nervous system) depressants whereas caffeine present in coffee, etc., acts as a CNS stimulant. So, the word "beverage" used for caffeine present in tea and coffee is misleading.

**Sandeep Jain**  
*Department of Pharmacy*  
*Govt. Medical College*  
*Amritsar (Punjab)*

### More veterinary science

Sir, I am a regular reader of S.R. for more than half a decade. Being a village dweller, I request you to publish medical notes on veterinary science issues too. It is indeed pathetic to see the suffering of diseased animals and livestock.

**S. Prakash**  
*Vellalar Street*  
*Mutharasanallur*  
*Tiruchi-620101*  
*Tamil Nadu*

### Pollution

Sir, I must thank Y.P. Gupta for his informative and educative article **Pollution poisoning** (S.R., March 1989). The article is written in a lucid

and easy language. But a few paras on 'how to monitor pollution could have been added. I hope to see more articles on environment in coming issues.

**Prince Rafiq**  
*Moh. Bakshi-Abad*  
*Islamabad, Kashmir*

### Medical Notes

Sir, I am a biology student of class 12th (10+2 level). I am a new reader of *Science Reporter*. I read with interest 'Medical Notes' by Samarendra Nath Banerjee (S.R., Jan. 1989). It was a very useful and educative article for every science student. I hope you will continue to publish such articles in future. The cover story on **Biotechnology in agriculture** was also very interesting. The section which I enjoy most in the magazine is 'Science Spectrum'.

**Girijesh Kumar Singh**  
*Tendua*  
*Distt. Gorakhpur-273001*  
*Uttar Pradesh*

### Errata

In the S.R., April-May 1989, page 192, the photograph shown is that of *Werner Heisenberg* and not of *Wolfgang Pauli* as stated.

—Editor

## Extramural research support given by CSIR

Since Independence in 1947, one of the major activities of CSIR has been in the area of extramural scientific and industrial research. Several schemes have been evolved for supporting research by talented Ph.D. students, postdoctoral scholars, faculty and staff members of different Universities and R & D institutions and eminent superannuated scientists. In addition, CSIR has provision for financial support towards organisation of useful and productive seminars, symposia or conferences and visits by meritorious postgraduate and postdoctoral

research scholars and faculty members to attend suitable international meetings for presentation of research papers. Some information about extramural research (EMR) schemes is given in the Table below. All queries and correspondence about the EMR-work of CSIR may be addressed either to: *the Under Secretary (EMR), CSIR-Complex, Hillside Road, New Delhi-110012* or to *the Head, Human Resource Development (HRD) Group, CSIR Headquarters, Rafi Marg, New Delhi-110001.*

### Extramural research promotion programmes of CSIR

Activity	EMR-grant		Usual time for application <sup>d</sup>	Eligibility <sup>e</sup> Qualifications/age	Selection procedure
	Tenure	Amount/stipend			
Junior Research Fellowship (JRF) <sup>a</sup>	2 years, extendable by 1 year	Rs. 1800/- p.m. <sup>b</sup> with annual contingent grant of Rs. 7500/-	November <sup>c</sup> Advertised in Employment News	M.Sc.; Age limit 28 years	Merit in CSIR-UGC Joint Examination
Senior Research Fellowship (SRF) <sup>a</sup>	JRF + SRF = 5 years SRF = 3 years	Basic science awardees, Rs. 2100/- p.m. <sup>b</sup> ; Engineering & Medical Sciences awardees, Rs. 2400/- p.m.; and contingent grant of Rs. 7500/- annually.	June/December, Advertised in Employment News	M.Sc. with 2 years research experience; M. Pharm., M.B.B.S. with one year internship; M.E., M. Tech. or equivalent degrees; Age limit 32 years	Evaluation by discipline wise expert Committees on the basis of documents submitted/ personal discussion
Research Associateship (RA)	5 years (3 + 2 years)	Rs. 2200-100-2700, Rs. 2700-100-3200, Rs. 3200-100-3700 or Rs. 3700-125-4325 <sup>b, f</sup> and a contingent grant of Rs. 10,000/-	June/December, Advertised in Employment News	Ph. D. having research publications; M.E. or M. Tech. having 3 years experience; M.D., all with good academic record; Age limit 35 years	—do—
Research Scheme	Usually 3 years	Varies, upto 5 lakhs during the entire period	Any time during the year	All levels of scientists employed in Universities, Research Institutions and R & D Units	Evaluation by referees and area-wise research Committees; Committees meet twice a year
Emeritus Scientist Scheme	Normally up to the age of 65 years	Rs. 3500/-, a suitable contingency grant & Research Fellow/ Associate	—do—	Eminent superannuated Scientists	Evaluation by referees and the Standing Committee(s)
Visiting Associateship	3 years	TA & DA for two visits to a CSIR Laboratory, totalling 60 days in a year	Any time during the year	Middle level Scientists from Universities/R&D Units in Industry	Evaluation by Committee(s)
Indian Language Journal	Year to year basis	Varies between Rs. 5000/- to Rs. 10,000/- per year	—do—	Only journals brought out in Indian languages with the sole intention of popularizing science	—do—
Travel Grant	For presentation of research paper at international meeting	50% to 100% of air fare	—do—; preferably 3 months before the event	Research Fellows and Research Associates, invited, and whose research papers have been accepted for presentation	Evaluation by a Committee which meets 9-12 times in a year
Grant for holding symposium/seminar etc.		Partial support; Varying between Rs. 5000/- to Rs. 20,000/-	—do—	Seminars, Symposia, Conferences, etc.	—do—

(a) JRFs and SRFs are expected to register for Ph. D. degree;

(b) HRA is given according to the rules of organisation where working;

(c) Proposal for holding examination twice in a calendar year is under consideration;

(d) Further details, terms and conditions and application proformas, that are not published in Employment News, can be had from the Under Secretary, or Head, Extramural Research Division, Human Resource Development Group, CSIR Complex, NPL Campus, Hillside Road, New Delhi-110 012;

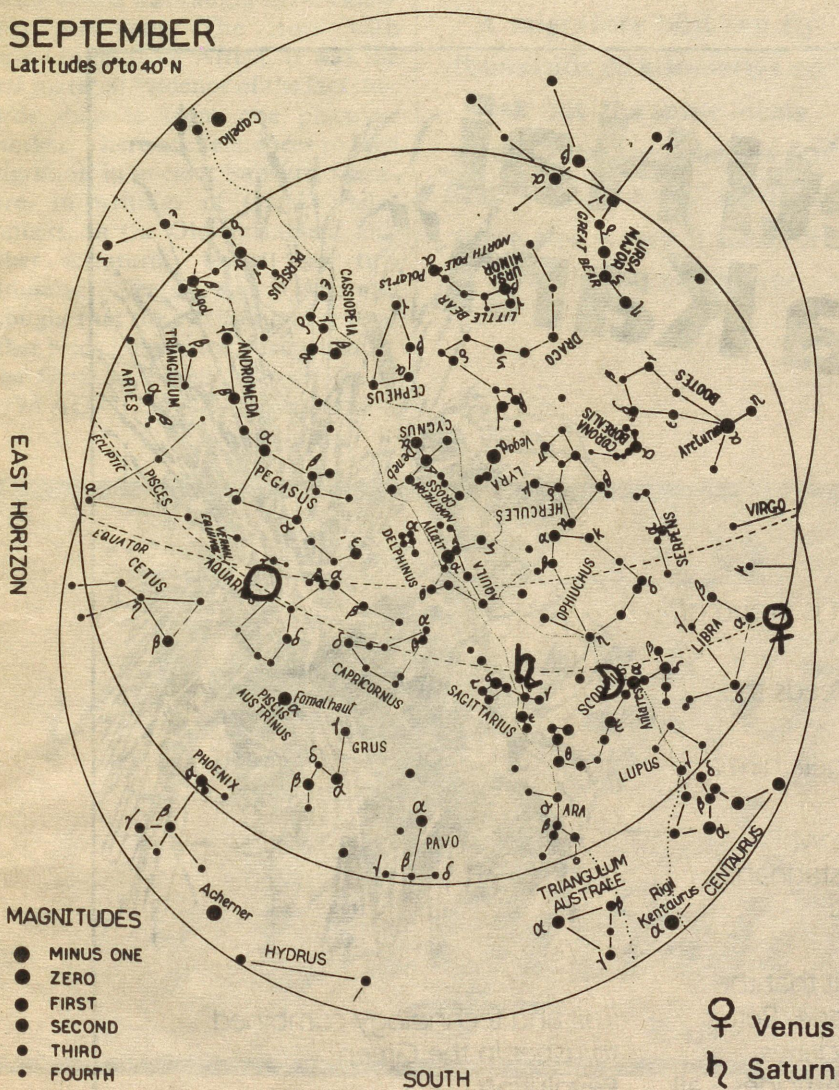
(e) For JRF, SRF and RA positions, relaxation in age limits up to 5 years for SC/ST candidates and marginally for highly meritorious general candidates will be considered;

(f) The stipend can be fixed in any of the four slabs depending upon qualifications/experience

# STARS AND PLANETS

## SEPTEMBER

Latitudes 0° to 40° N



Planetary positions for September 1989

Date	1st		10th		20th	
	R.A.	Decln.	R.A.	Decln.	R.A.	Decln.
Mercury	12h 16m	4.7S	12h 32m	7.7S	12h 19m	6.2S
Venus	13h 01m	6.4S	13h 40m	10.9S	14h 24m	15.5S
Mars	11h 18m	5.6N	11h 39m	3.3N	12h 02m	0.7N
Jupiter	6h 26m	23.0N	6h 31m	22.9N	6h 37m	22.9N
Saturn	18h 32m	22.7S	18h 32m	22.8S	18h 32m	22.8S

Adopted from figures supplied by Positional Astronomy Centre, Calcutta

### The moon

**F**ULL moon occurs on 15th at 5-21 p.m. and the new moon occurs on 30th at 3-17 a.m. I.S.T. The

moon passes about half a degree south of Mercury on 2nd, about four and a half degrees south of Venus on

4th, four and a half degrees south of Saturn on 10th and about four degrees north of Jupiter in the early hours of 23rd. The moon is at apogee or farthest from the earth on 4th and is at perigee or nearest to it on 16th. The lunar crescent becomes first visible after the new moon day in the evening of 2nd. In the southern part of India it is likely to be visible one day earlier, i.e., on 1st.

The earth is in autumnal equinox on 23rd.

### The planets

**Mercury (Budha)**, visible in the evening sky, sets about an hour after sunset during the first half of the month. Thereafter it comes too close to the sun to be visible being in inferior conjunction with the sun on 25th. It becomes retrograde on 12th. It is in Virgo (*Kanya*). Its visual magnitude varies from +0.3 to +1.2.

**Venus (Sukra)**, visible in the evening sky, sets about two hours after sunset during the month. It passes about 1°.9 north of the star Spica (*Chitra*) on 6th. It moves from Virgo (*Kanya*) to Libra (*Tula*). Its visual magnitude is about -4.1.

**Mars (Mangala)** is too close to the sun to be visible during the month being in conjunction with it on 30th. It moves from Leo (*Simha*) to Virgo (*Kanya*).

**Jupiter (Brihaspati)**, visible in the morning sky, rises about half an hour after local midnight during the first half of the month and about half an hour before it during the second half. It is in Gemini (*Mithuna*). Its visual magnitude is about -2.2.

**Saturn (Sani)**, visible in the evening sky, sets about half an hour after local midnight during the first half of the month and about half an hour before it during the second half. It becomes direct on 11th. It is in Sagittarius (*Dhanus*). Its visual magnitude is about +0.5.

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

# "Kheti Hai Mera Kam"

Smiling Gangaram is proud of his profession.

A profession that feeds the nation.

A profession that gets him a good income.

Gone are the days when agriculture was a stagnant avocation, a losing proposition,

Free India saw to it that the farmers get their due. Better seeds, irrigation facilities, power, fertilizer, pesticides - all at subsidised rates.

Timely credit and good price for the produce were ensured. Farmers fully made use of the facilities.



Toil and technology combined to usher in the Green Revolution.

Today India's foodgrain production is touching the 170 million tonne mark - 120 million tonnes more than in 1947.

## Progress that Makes Us Proud

davp 89/170

**F**OR ornithologists, May 21, 1822 is a red letter day. On that day a stork with its neck pierced by an exotic arrow was caught in Mecklenburg, Germany. The stork with arrow came from Africa. It was the first material evidence of the fact that birds migrate from one place to another. There are references to bird migration in ancient Sanskrit literature, in writings of Greek philosophers, in the Old Testament and other scriptures. More than two thousand years ago, Aristotle thought that the swallow and several other birds hibernated during winter. The German Emperor Friedrich II (1194 AD—1250 AD) noticed south-

**A migratory bird can fly thousands of kilometers and seek out the same locale where it had been before and find the same spot, often the same tree where it made its nest the previous year**

#### **Stimulus for migration**

Environmental factors like availability of food, changes in temperature, etc., are often suggested as the causes that trigger migration. Some experiments have shown that photoperiodism (i.e., response to change of length of day) provides the stimulus to migrate. Captive birds were induced to 'migrate' about two months earlier than usual by subjecting them to artificially changed day-length. Other experiments, however, did not give the same result. Warblers (*Sylvia* sp.) are small birds that breed in central and northern Europe and migrate in autumn to southern Africa. In one experiment, fledglings



# Mystery of Migration

RANATOSH CHAKRABARTI

bound flights of birds while crossing the Mediterranean Sea. He suggested that European birds moved to southern countries in winter.

Birds are not the only creatures that migrate. Animals, like insects, fish, reptiles, big mammals and others, also travel hundreds and thousands of kilometers to seek suitable environments. But migration of birds is on a far larger scale than any of the others. A migratory bird can fly thousands of kilometers and seek out the same locale where it had been before and find the same spot, often the same tree where it made its nest the previous year.

Why birds migrate is still a mystery. One might think that they do so to escape from cold, to find food, or to choose breeding places. But it can at best be part of the answer. Most birds travel much further than would be necessary to find food and favourable weather. Moreover, some birds stay at home and feel no urge to migrate in spite of cold and shortage of food.

At least two fundamental points are worth consideration in this aspect. The first is the timing of the stimulus for migration, and the second is the navigation during migration.

were taken from the nest in spring and divided into four groups. Two groups were kept in Germany—one kept at constant temperature and other in a schedule of 12-hour light and 12-hour darkness by artificial means. The remaining two groups were flown to the birds' wintering place in Africa. Surprisingly, birds of all the four groups showed almost similar behaviour.

It has also been postulated that environmental changes cause some change in endocrine system of birds. The neuroendocrine axis is stimulated either by visual or by other sensory impulse, presumably through

hypothalamus of brain. As a consequence, some hormonal changes occur. These changes cause restlessness in birds inducing them to migrate. Thus, according to one theory, the timing of regular long-distance migrations has been built into an internal hormonal cycle in course of evolution.

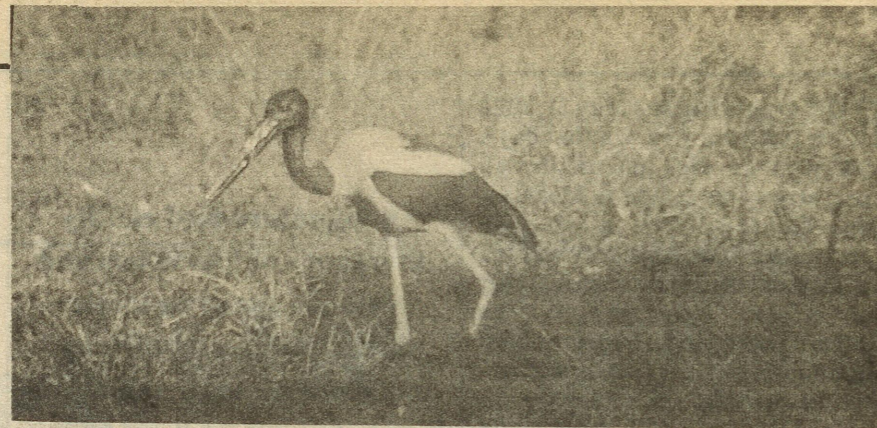
The search for the triggering stimulus that sets off bird migration has ranged over great diversity of possible factors. Many attempts have been made to identify the factors, but no decisive conclusion has been possible as yet. Probably, more subtle factors are involved.

#### Gruelling journey

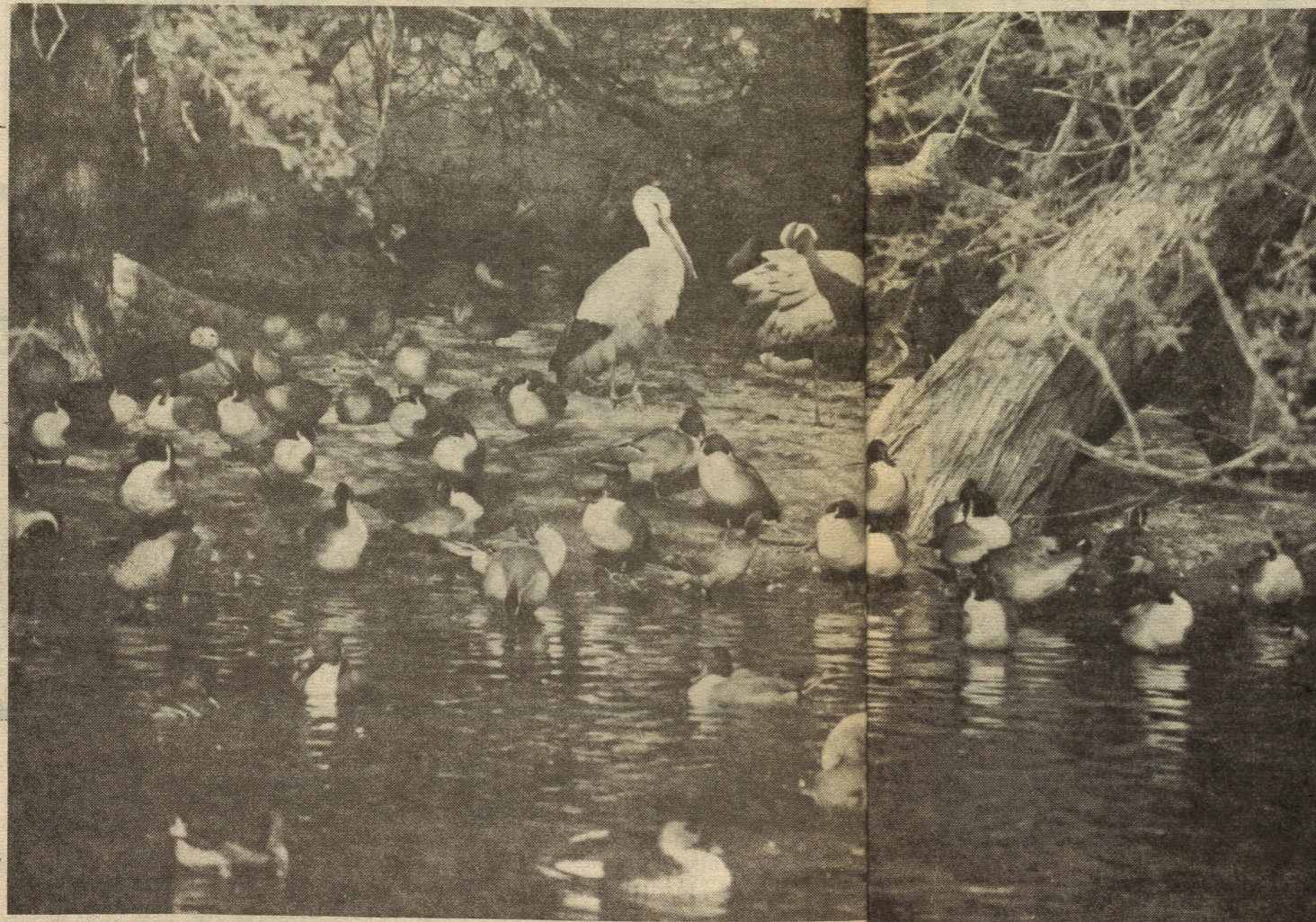
Of the nine thousand species of birds that inhabit the earth almost two thirds are migratory. Some of them travel extremely long distances in course of a few weeks or months. The American golden plover (*Pluvialis dominica*), flies from Arctic to South America—a distance of about 7000 km. The ruby-throated humming bird (*Archilocus colubris*), only nine centimetres in size, flies about 2500 km from Canada to Florida (U.S.A.). The swallow (*Hirund* sp.), measuring 12-15 cm, flies almost 7000 km from Europe to South Africa after crossing the Atlantic. The blue-winged teal (*Anas discors*), which nests upto 60°N in North America, winters down to beyond 30°S, a distance of over 9,500 km. The northern pintail duck (*Anas acuta*) and gargany (*Anas querquedula*), which breed in the Siberian tundra and taiga, are not less remarkable for their long journey in winter. The white stork (*Ciconia ciconia*) of

Migratory water birds in Delhi Zoo (Photo : Biman Basu)

Siberian crane (below), a regular migrant to India (Photo : Dimesh Sinha)



Blacknecked crane (Photo : Dinesh Sinha)



Europe and northern Asia is another example of long-distance migrant, travelling as far as southern Africa and India. Different types of teals, ducks of east Siberia and northern Asia migrate to India and Southeast Asian countries. Some of them even cross the lofty Himalayas on their way. But most remarkable is the migration of the Arctic Tern (*Sterna*

*paradisaea*). In a single year it flies from the Arctic to Antarctic and back, covering a total distance of 23,200 km.

#### Navigation

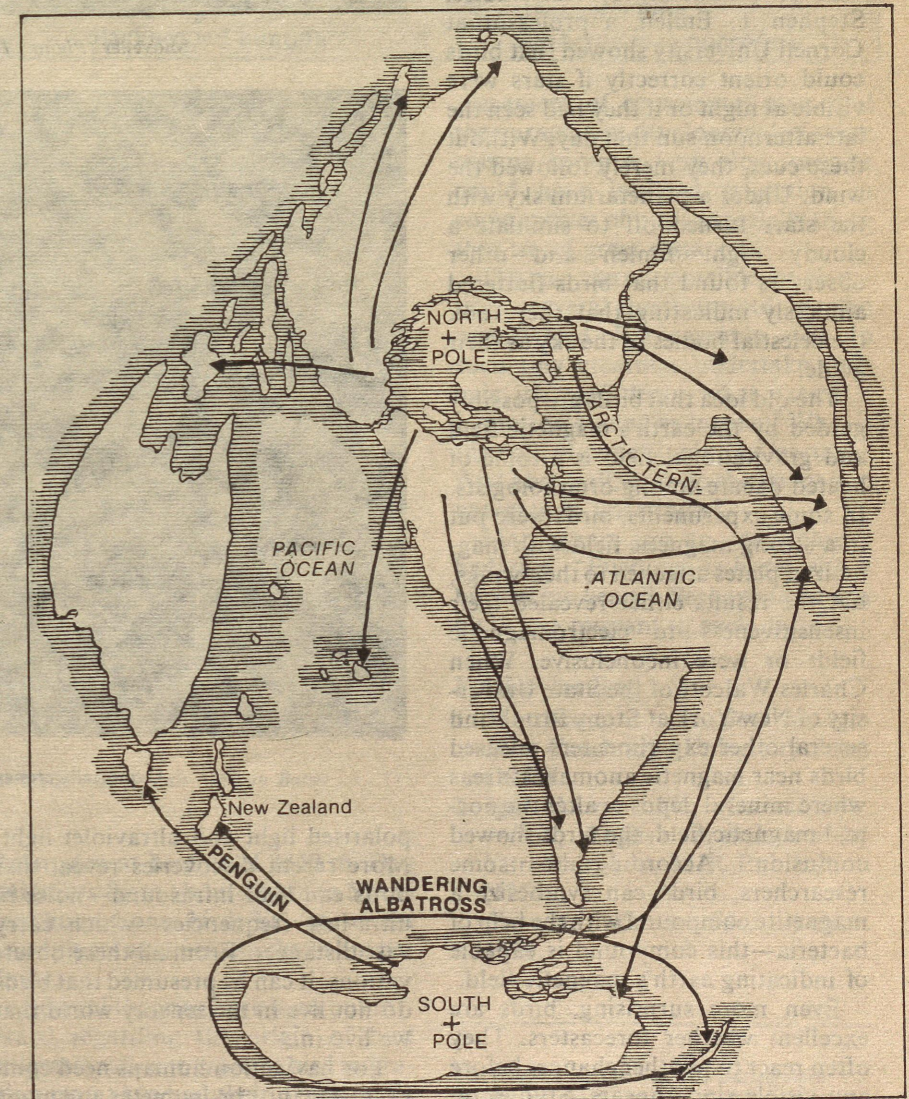
It has long been known that the domesticated pigeon can find its way home after having been transported to a strange location. Another bird, the little wild Manx Shearwater, taken from its nest off the coast of Wales (U.K.), carried and released in



Crane (Photo : Biman Basu)

revealed fascinating facts.

Birds navigate not only with the help of the sun but they also take cue from the position of stars and planets of the night sky. Navigation by birds with the help of the sun was probably first described by the German biologist F.A. Schneider in 1906. Since then, the idea of solar navigation has been discussed time and again. But it was Gustav Kramer who with the help of his own designed cages performed various experiments on starlings, warblers and other migratory birds and showed that in choosing the right direction the birds orient themselves by the sun. The experiments of Kramer, G.V.T. Matthews,



Migratory routes of birds

Boston (U.S.A.), surprisingly, returned to its nest in twelve days. The navigation of birds (a better term should be avigation) has been studied using advanced technological devices like radar, placing birds in planetarium, putting bands of light metal or plastic in their legs which reveal time of capture, year, etc., and in many other ways. These studies have

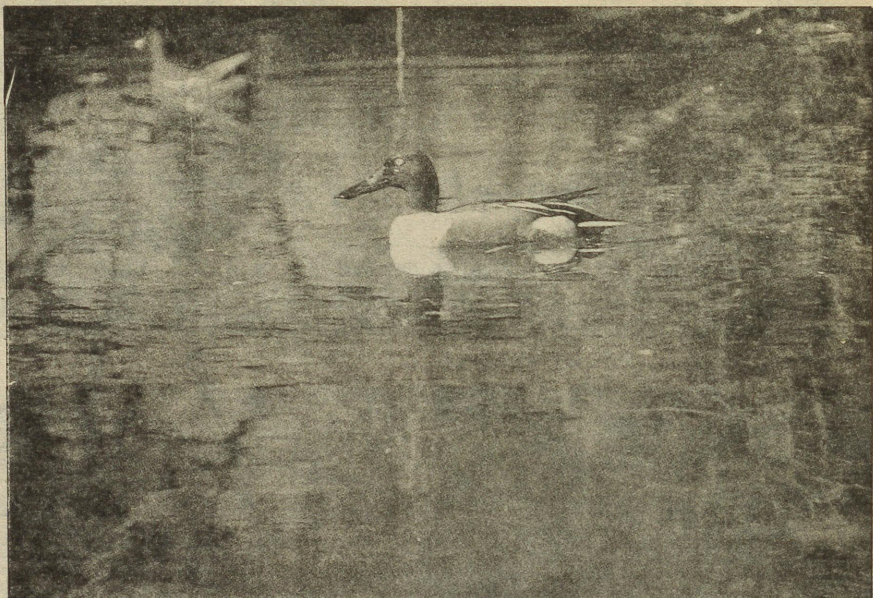
**The old idea that birds are possibly guided by the earth's magnetic field and gravitational field is a topic of heated debate among ornithologists.**

E. Sauer and others indicate that for navigation birds use the sun as the chief guide. The theory of sun navigation is a great advancement of scientific thought, yet scientists are still unable to explain how birds crossing the equator continue to orient themselves by the sun.

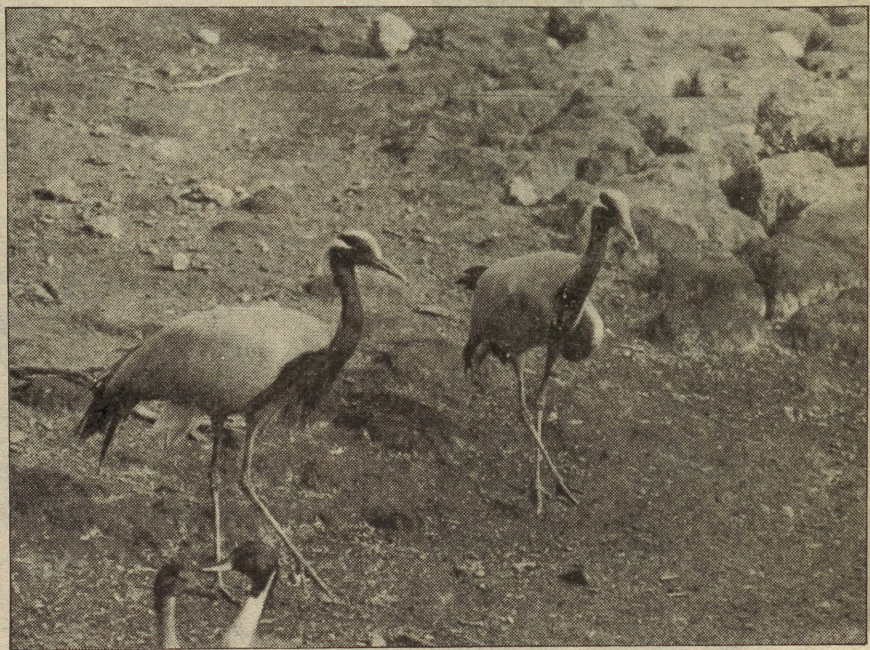
After conducting several studies, Stephen T. Emlen, a professor at Cornell University showed that birds could orient correctly if stars were visible at night or if they had seen the late afternoon sun that day. Without these cues, they merely followed the wind. Under a planetarium sky with the stars turned off to simulate a cloudy night Emlen and other observers found that birds fluttered aimlessly indicating that they took the celestial bodies of the sky as their guide.

The old idea that birds are possibly guided by the earth's magnetic field and gravitational field is a topic of heated debate among ornithologists. In some experiments, birds were put in a strong magnetic field with magnetized plates attached to their wings, but the results either revealed their insensitiveness to electromagnetic fields or were inconclusive. When Charles Walcott of the State University of New York at Stony Brook and several other experimenters released birds near magnetic anomalies, areas where mineral deposits alter the normal magnetic field, the birds showed confusion. According to some researchers, birds can synthesize a magnetite compound with the help of bacteria—this compound is capable of indicating earth's magnetic field.

Even more surprising, birds are excellent weather forecasters. They often react to weather changes before any visible sign appears. Studies on pigeons have shown that they can see



Shoveller (Photo : Dinesh Sinha)



Demoiselle cranes (Photo : Biman Basu)

polarised light and ultraviolet light. More recent discoveries reveal that birds can hear infrasound—noise in ultra-low frequencies—which carry vast distances. From all these observations, it can be presumed that birds do not live in the sensory world that we live in.

For navigation humans need compass, sextant, chronometer and many other sophisticated instruments and

yet they find them inadequate. But the tiny birds use only their 'biological instruments'. True navigation needs something more than instruments—a knowledge of position. If a sailor, for example, has to calculate his latitude and longitude, he has not only to know the sun angle, but has also to have a precise knowledge of his own time compared to the time of Greenwich—in what is

called bi-coordinate navigation. But there is no evidence that a bird does anything of this kind for its gruelling journey. The true nature of the navigation system of migratory birds is still not clearly understood.

### Physiological fitness

The physiological fitness of migratory birds helps in their long journey. The eye-sight of birds is very sharp. Their pectoral muscles that bear the wings are quite strong and well developed to help them fly long distances. Their respiratory system is well adapted for their metabolic needs. A countercurrent flow of blood and air in the pulmonary bed enables them to get oxygen with an efficiency far better than any other vertebrates. Most migratory birds build up body fat reserve before embarking on their

### Some migrants to India

Barheaded geese	<i>Anser indicus</i>
Shoveller	<i>Anas clypeata</i>
White-eyed pochard	<i>Aythya myroca</i>
Brahminy duck	<i>Tadorna ferruginea</i>
Pintail	<i>Anus acuta</i>
Common teal	<i>Anus crecca</i>
Garganey	<i>Anus querquedula</i>
Mallard	<i>Anus platyrhynchos</i>
Gadwall	<i>Anus strepera</i>
Wigeon	<i>Anus penelope</i>
Tufted pochard	<i>Aythya fuligula</i>
Redcrested pochard	<i>Netta rufina</i>
Ruff	<i>Philomachus pugnax</i>
Blacktailed godwit	<i>Limosa Limosa</i>
Yellow wagtail	<i>Motacilla flava</i>
Common swallow	<i>Hirundo rustica</i>
Rosy pastor	<i>Sturnus roseus</i>
Blue throat	<i>Erithacus svecicus</i>
White wagtail	<i>Motacilla alba</i>
Blackheaded bunting	<i>Emberiza melanocephala</i>



Painted storks and their chicks at the Delhi Zoo (Photo : Biman Basu)

migratory journey so that they can fly non-stop 3 to 4 days while crossing oceans. Ornithologists like R.I.G. Morrison have observed that some birds nearly double their weight within three weeks prior to migration. Most of the birds stay at heights of 250m-300m during their long flights, although birds like geese while crossing the Himalayas have

been seen at heights of 8840 m. Day migrants fly at about 30 km to 50 km per hour. Some birds like geese and sandpipers at times can fly 90 km per hour.

Several theories have been put forward regarding the origin of bird migration. Some types of bird migration may have had their origin in the continental drift. Rifting and dis-

placement of continental mass and the consequent development of some oceans being a very slow process could have initiated migration in some species of birds especially those that travel great distances.

Despite many possible explanations, several questions still remain unanswered. For example, why do such tiny creatures undertake such epic journey? Upto what extent is migration guided by instinct? What is the role of conditioning or learning? And above all, how do they pilot and navigate so unerringly?

Many years ago an ornithologist had said, "Everyone is born with a bird in his heart". Perhaps there is a bit of the migrant in each of us.

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ANIL H. LACHKE

# LIQUID FUEL FROM SOLID WASTE

**T**HE incentives for energy recovery from wastes are most attractive in the rural areas of developing countries. Lignocellulose as a raw material for bioconversion has a role in energy production; it can prevent deterioration of the environment, and facilitate waste management. Large quantities of lignocellulosic material in the form of agricultural and forest residues are available in India. For example, India's production of wheat straw and rice straw is approximately 200 million tonnes per year. Although straw has low protein content, it is rich in fermentable carbohydrates. Similarly, hemicellulose-rich waste materials like corn-cob or coconut pith and shell are a valuable resource. Production of coconuts in India is as high as 6000 million nuts per year. Thus coconut shells rich in hemicellulose are available in large quantities and can be considered for bioconversion into useful products.

The major constituents of lignocellulosic substrates are cellulose, hemicellulose and lignin which are present in an average proportion of 4:3:3. This proportion varies significantly in their native states. Some of the commonly occurring hemicelluloses are arabinoxylan, glucoxylans and arabinogalactans. Depending on the biomass source, the hemicellulose fraction can be as much as 85% xylan. Xylan on hydrolysis yields D-xylose as the major product. Cellulose, hemicellulose and lignin contents in a few agricultural and forest residues are given in Table 1.

**D-xylose, the second most abundant sugar in the biosphere, offers great potential as a feedstock for generating fuel**

## Hemicelluloses and recovery of pentose sugars

Hemicelluloses have a relatively open structure as compared to cellulose (Fig. 1). This facilitates diffusion of acid into the polymer resulting in accelerated hydrolysis of xylans. Thus, hemicellulosic sugars can be obtained more readily, with better yield (80%-90%) from xylan by acid or enzymic hydrolysis as compared to the D-glucose yield (50%) from cellulose. Glucose is the well-known fermentable six-carbon sugar and can be easily used for the production of food/fuel. However, about 40% of the total carbohydrates obtained from plant materials consist of hemicellulosic, five-carbon sugars. Thus, D-xylose is the second most abundant sugar in the biosphere offering us a potential feedstock for generating food or fuel.

The enzymic hydrolysis of xylan to produce monomeric sugars requires synergistic action of at least two enzymes, namely,  $\beta$ -D-xylanase and  $\beta$ -D-xylosidase. Using microbial xyl-

anases the hydrolysis of xylans to monomeric sugars has been achieved by several investigators. A few streptomycetes and fungi (e.g., *Sclerotium rolfsii* and *Penicillium funiculosum*) have been reported to produce enhanced levels of xylanolytic enzymes.

## Yeasts that utilize pentose sugars

The economic viability of ethanol production from lignocellulose can be considerably enhanced if the pentose sugar, D-xylose, can be fermented to ethanol. Screening is one approach to obtain yeasts which convert D-xylose to ethanol. Many yeasts metabolize D-xylose and D-xylulose aerobically, but not anaerobically, producing xylitol and ethanol as useful byproducts, often with high conversion efficiencies. *Saccharomyces cerevisiae* and *Saccharomyces pombe*—the well-known yeasts which produce ethanol from glucose—are also able to produce ethanol from D-xylulose, but they cannot use D-xylose.

## Production of xylitol from D-xylose

Several yeasts (*Candida polymorpha*, *Pichia miso*) can aerobically convert D-xylose to xylitol as the major product. This finding is also encouraging since xylitol, a sugar alcohol, is a natural sweetener present in small quantities in a wide variety of fruits and vegetables. Xylitol does not form acid and may thus be used clinically as a sugar substitute in treatment of diabetes or when there is a deficiency of D-glucose-6-phosphate dehydrogenase. Xylitol is

frequently used in chewing gums and toothpaste. Several yeasts are known to convert D-xylose to xylitol but the conversion efficiency is only 50%. Using a mutant strain of *Candida tropicalis* HXP2, efficient xylitol production from D-xylose has been achieved.

#### Production of ethanol from D-xylose

During the last few years, yeasts namely *Pachysolen tannophilus*, *Candida shehatae*, *Pichia stipitis* and *Candida tropicalis* have been identified for ethanol production from D-xylose in appreciable yields under well defined aerobic or anaerobic conditions. Some moulds such as *Fusarium*, *Rhizopus* and *Mucor* are also known to ferment D-xylose to ethanol. Many bacteria are able to utilize xylose; especially members of the genera *Clostridium* and *Bacillus*

Table 1. Appropriate composition \* of selected lignocelluloses

Lignocellulose substrate	Cellulose	Hemicellulose	Lignin
Rice straw	37	24	14
Wheat straw	31	29	18
Bagasse (fresh)	34	30	20
Bamboo	40	20	20
Subabul	33	20	NA
Mesta wood	35	18	NA

\* Subject to variation

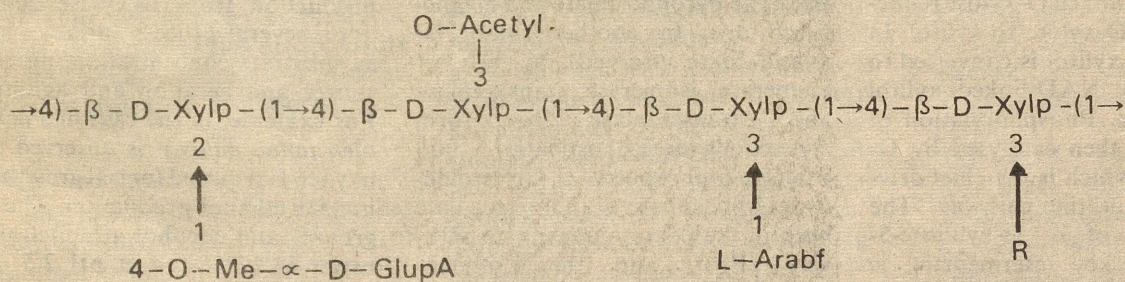
(*B. mascerans*) carry out mixed fermentation in which ethanol is a major end product. The main problems in the use of bacteria are low ethanol tolerance and the formation of products other than ethanol.

#### Biochemical steps in ethanol production

The metabolic steps involved in the fermentation of six-carbon sugars have extensively been studied. In

contrast, D-xylose metabolism in yeasts is a phenomenon only recently demonstrated. The initial biochemical step in D-xylose fermentation is the isomerization of D-xylose to D-xylulose, the corresponding keto isomer (Fig. 2). There are two different pathways for this reaction. Direct isomerization catalysed by a D-xylose isomerase is thought to be the prevailing mechanism in bacteria. In yeasts and moulds, D-xylose is

#### GENERAL STRUCTURE FOR D-XYLANS



R IS  $\beta\text{-D-Xylp} - (1 \rightarrow 2) - \text{L-Arabf} - (1 \rightarrow$ ,  $\alpha\text{-D-Xylp} - (1 \rightarrow 3) - \text{L-Arabf} - (1 \rightarrow$ , or  $\text{D-Galp} - (1 \rightarrow 4) - \text{D-Xylp} - (1 \rightarrow 2) - \text{L-Arabf} - (1 \rightarrow$

#### SECTION OF XYLAN CHAIN WITH NON-REDUCING END OF L-ARABINOFURANOSIDE

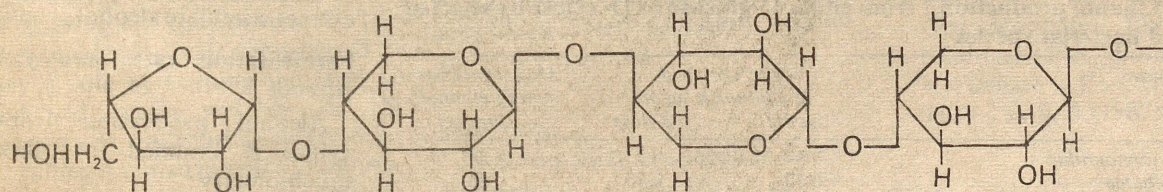


Fig. 1

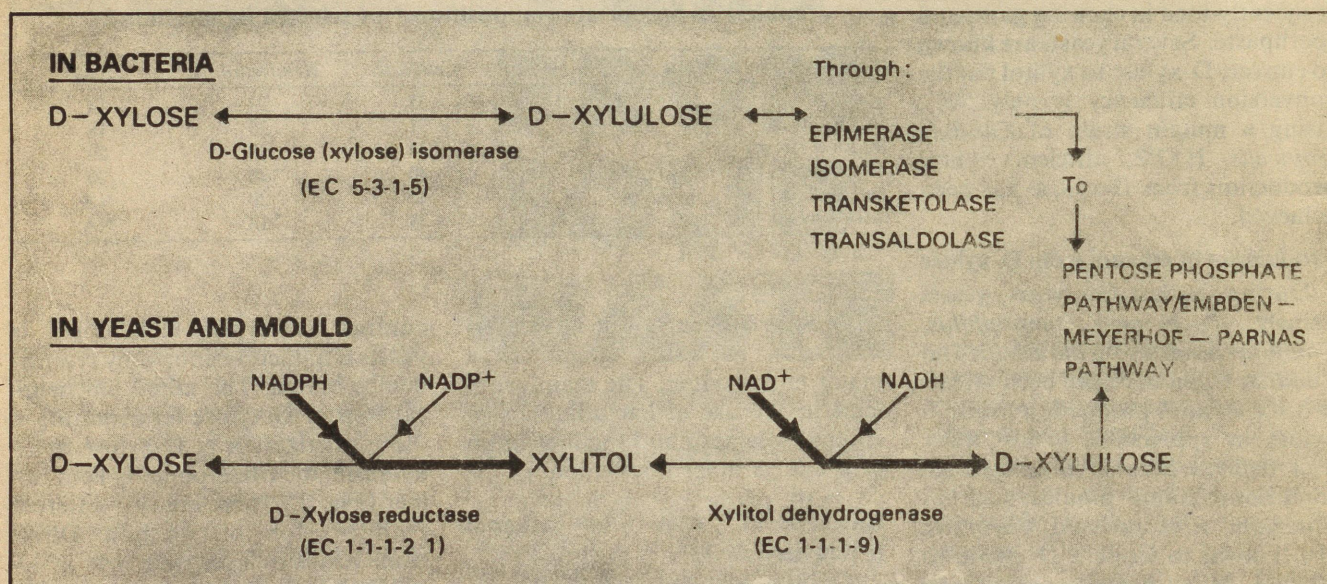


Fig. 2

isomerised in two enzymic steps involving reduction and oxidation. The NADPH-linked D-xylose reductase converts D-xylose to xylitol. In the next step, xylitol is converted to D-xylulose by NAD-linked xylitol dehydrogenase. Phosphorylation of D-xylulose is then catalysed by D-xylulokinase which is the chief driving reaction in the pathway. The formation of D-xylulose-5-phosphate, a key intermediate, is similar to hexokinase in the metabolism of D-glucose. Beyond this point, much of the pathway is assumed from biochemical studies with other organisms. In one route, phosphoketolase (phosphate acetylating) converts D-xylulose-5-phosphate to

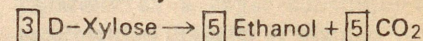
glyceraldehyde-3-phosphate and acetyl phosphate in the presence of thiamine pyrophosphate and magnesium ions. In another route, D-xylulokinase proceeds by way of epimerase, isomerase, transketolase and transaldolase to form glyceraldehyde-3-phosphate and fructose-6-phosphate. Glyceraldehyde-3-phosphate is an intermediate both in the pentose phosphate pathway (PPP) and the Embden-Meyerhof-Parnas (EMP) pathway. A high ratio of NADH/NADPH-linked D-xylose reductase activity and an elevated level of alcohol dehydrogenase are important for ethanol production from D-xylose using yeasts.

#### Culture conditions

The rates and yields of ethanol production from D-xylose depend upon several process variables such as substrate concentration, nitrogen source and aeration and agitation. For example, in the case of *Pachysolen tannophilus* it is observed that oxygen is required for cell growth but not for ethanol production. The cell growth and alcohol production is better at 32°C and at pH 2.5. The ethanol production is subject to substrate (55 g xylose/litre) and product (30 g ethanol/litre) inhibition. Growth on nitrate can induce *P. tannophilus* cells to higher specific fermentation rates when they are transferred to a less reactive nitrogen source. Peptone, casein and yeast extract stimulate alcohol production.

#### Fermentation rates and yield of ethanol

Alcohol production from D-xylose is assumed to follow the stoichiometry:



This indicates that about 2/3rd of the substrate carbon will go to

Table 2. Ethanol production \* from either D-glucose or D-xylose by selected yeasts and bacterial species

Microorganism	Average yield (g ethanol/g sugar)		Max. concentration (g ethanol/litre)
	Glucose	Xylose	
<i>Pachysolen tannophilus</i>	0.47	0.33	38
<i>Candida shehatae</i>	0.33	0.30	26
<i>Saccharomyces cerevisiae</i>	0.50	do	88
		not	
<i>Zymomonas mobilis</i>	0.50	ferment	102

\* Average values

ethanol and 1/3rd to carbon dioxide. The yeast species, namely, *P. tannophilus*, *C. shehatae*, *C. tropicalis* and *P. stipitis* are able to convert D-xylose to alcohol but yields of alcohol are not satisfactory. The yields are lower than the theoretical yields (Table 2). On mass basis, 0.51 g alcohol should be obtained from 1 g of D-xylose. One of the main reasons for the low yield is the formation of other fermentation products such as xylitol, acetate, etc., yields of 0.3 g ethanol/g of D-xylose have been reported with *C. tropicalis*. Other reported values are with *C. shehatae*, 0.29 g/g; and with *Kluyveromyces marxianus*, 0.28 g/g. For *P. tannophilus*, higher yield of 0.34 g/g sugar was reported which was further increased to 0.4 g/g by cell recycling and immobilization. The low alcohol yield as compared to the theoretical value in case of *P. tannophilus* has been attributed to the concurrent utilization of ethanol and formation of xylitol as well as other by-products. Thus, the strains which do not utilize ethanol and ferment D-xylose to ethanol appear to be important.

#### New developments

Improvement in the yields has been achieved by strain improvement through mutation studies. The biochemical basis and rate limiting steps for D-xylose utilization of promising yeasts and their mutants are being studied in greater details. The higher rate of ethanol production as the result of cell recycling is due, in part, to the high cell density, which provides a large number of cells capable of carrying out the conversion. The high cell density is also considered to play a role by keeping the level of dissolved oxygen suitably low. By choosing an appropriate interval for recycling, it is also possible to minimize alcohol loss due to oxidation. Removal of inhibitory products and replenishment of trace nutrients are beneficial for improving the rate of

ethanol production. The study of these factors will facilitate the development of a controlled fermentation system and also may serve as a basis to obtain genetically engineered strains. To economize the process, sizeable benefits can be obtained by improving the recovery of the by-products such as acetic acid, glycerol and xylitol. The possible production of novel chemicals from pentose phosphate pathway along with traditional products such as citric acid, amino acids, vitamins and antibiotics should be explored. The fermentation of pentose sugar is practicable only where it is a by-product of lignocellulose processing. Another necessary feature for the development of biotechnology is the adaptation of yeasts for fermentation process using waste-streams or hydrolysates.

Ethanol production from pentose sugar is still in the developmental stage. To obtain suitable yeasts, a gene encoding for D-xylose isomerase in *Escherichia coli* was cloned. Appropriate induction of this gene into a suitable yeast host is expected to allow the transformant to convert D-xylose into ethanol. If molecular cloning proves difficult, fusion of protoplasts from *P. tannophilus* and another yeast may be practicable. Another approach consists of using microbial isomerases to transform D-xylose into D-xylulose which can be fermented by normal yeasts. The main problem in this process is the isomerization which introduces an additional cost factor. Moreover, the equilibrium of isomerization reaction is more on the D-xylose side which makes recirculation of the fermentation liquid necessary if good yields are required.

#### Prospects

It is too early to speculate on the commercial significance of the second most abundant sugar available in nature. The economy of India is largely based on agriculture and we

have various potential substrates for bio-conversion. We must be aware of the fact that there is scope in the research and development of the agro-based industries. Our outlook should always be like that of Henry Ford to whom somebody asked about the fate of his automobile business in the event of petroleum supplies of the world running out. He replied, "We can get fuel from fruit, from sumac by the road-side or from weeds, saw dust, ...almost anything. There is fuel in every bit of vegetable matter that can be fermented... and it remains for someone to find out how this fuel can be produced commercially... better fuel at a cheaper price than that we now know." This optimism must be appreciated in the light of emerging technologies for harnessing energy from biomass.

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**Gout is the name attributed to a condition characterised by increased levels of uric acid in blood, recurrent attacks of inflammation of and spontaneous pain in joints and tendons. It commonly occurs in men at or beyond the middle age**

# WHAT IS GOUT

K.G. PRASANNAN



The hand of a gout patient is shown at left. Excess uric acid causes crystals to form around the joints, producing the swellings characteristic of this disease. At right, the same hand after treatment

**G**OUT is the name given to a condition characterised by increased levels of uric acid in blood, recurrent attacks of inflammation of joints due to deposition of monosodium urate crystals in the cartilage,

tendons and sinova resulting in spontaneous pain, often severe, but lasting for a few days and followed by complete remission. The pain may be precipitated by injury, unaccustomed exercise or application of pressure to

the region. More commonly it may occur in men at or beyond the middle age (95%) than women (5%). In women, it is rarely seen until menopause.

### Primary and secondary gout

Gout is prevalent in Europe, United States of America and other affluent countries and comparatively much less in India. Two forms of gout are known. The first one is hereditary disorder characterized by an overproduction or underexcretion of uric acid. It is called primary gout and is associated with acute and chronic arthritis and deposition of urate crystals in the joints. 90% of the gout cases are of primary type which however is rare in India. Secondary gout which comprises 10% of all gout cases results from acquired conditions associated with increased turnover of nucleic acids as occurring in lukaemia or due to decreased excretion of uric acid as in renal failure. It may also be found in chronic alcoholics in late middle age groups. Secondary gout is common in India.

### History of gout

Gout was known to afflict man ever since the dawn of history. Hippocrates noted that gout affected only men but not women and eunuchs. During his time it was believed that gout was nature's punishment for those men who had excessively indulged in sexual activity! Galen, a successor to Hippocrates, described the accumulation of a noxious material in the joints and called it "tophus". The noxious accumulation in the joint was called in Latin as "gutta" (meaning "drop" or "coagulation") from which the English name "gout" and the Hindi name "Gathia" appear to have derived.

If we look into history, we may find that gout was associated with many eminent personalities during past few centuries. Many who were afflicted with this biochemical disorder had never succumbed to this condition but could live long without any appreciable bodily problem or misery and could achieve great success in life and become famous in history. King Alexander the Great of

Greece, King Louis VII and King Louis XIV of France, and Queen Anne of England were some of those who were afflicted with gout, but who have all lived long and had been credited with exceptional achievements. Since this disease was associated with kings, conquerors, monarchy and aristocracy, it was thought that the incidence of gout was related to a high standard of living. However, religious leaders like John Calvin and Martin Luther who had led exceptionally simple and exemplary life cut off from worldly pleasures and comforts were also afflicted with gout. Leonardo da Vinci, the great scientist and artist, was afflicted with gout for a long period of his life but that did not in any way affect his continued excellence in art and science. Other scientists who went on with their scientific pursuits were Sir Isaac Newton, Sir William Harvey and Thomas Sidenham, to mention a few, and all of them lived a long and useful life in spite of their having symptoms of gout. Men of letters like Samuel Johnson and John Milton also suffered from gout. It was not however known for many years whether these men were afflicted by this condition due to genetic constitution or environmental factors.

#### Uric acid, urates and gout

The nitrogenous metabolic product, uric acid, is derived from the purine portion of nucleic acids and as it is of no use to the body once it is formed, it is excreted as a waste product through the kidney. In normal blood, it occurs in the range 2.5-7.5 mg/100 ml. Its level is higher in males, viz., 4.5-7.5 mg, whereas in females it is 2.5-4.5 mg/100 ml. In gouty patients, the blood uric acid level is often always higher than normal (Hyperuricaemia). If the uric acid level in adolescent and young adult males is found to be continuously higher than normal, it may be considered as an early indication of development of gout in such individuals later in life. This happens in some families and may be hereditary. For months and years, they appear normal, but symptoms of gout start

appearing by the time they reach middle age (40-45 years of age). In women, however, no symptoms are seen until menopause. Once the menopause sets in the symptoms also start appearing spontaneously. Since the secretion of estrogens (female sex hormones) also slows down abruptly during this period the symptoms can appear as in men. During premenopausal years, it is believed, estrogens give women protection from gout.

#### How does gout develop?

The various biochemical and physiological factors responsible for development of hyperuricaemia and gout are now well-known. While in some cases it results from overproduction of purines which are ultimately converted to uric acid at an increasing rate, in other cases it is due to slowing down of the excretion of this compound, the production remaining normal. There are also cases in which both the production and excretion of uric acid proceed at a faster rate.

At the normal pH of blood plasma, uric acid remains as sodium urate.



Long-term, chronic gout has developed in this big toe which may need treatment for the rest of the patient's life

When the uric acid level is 6.4 mg/100 ml, all of it is present as a saturated solution of urate. But if the uric acid level further increases as in hyperuricaemia, urate tends to become insoluble. However, it does not get precipitated in plasma but is

kept soluble, thanks to the complexing with the albumin and globulin proteins of plasma. It is transported in this form throughout our body. When this urate-supersaturated plasma reaches the joint spaces where the pH tends to be lower because of acidic products from metabolic reactions, urate may crystallize out and get deposited. Once a small crystal is formed, more and more of crystals are formed gradually. This may take place first in the synovial fluid bathing the cartilage and tendons in the joint spaces. The microcrystalline forms of urate are swallowed (phagocytosed) by polymorphonuclear leukocytes which get destroyed during the process. The destroyed leukocytes liberate lysosomal enzymes which bring about inflammation of the area and pain in joints. The pain arises from certain pain-producing compounds called "kinins" formed there. The urate crystals reaching leukocytes also activate the Hageman factor which mediates inflammation.

#### Gout and food habits

Can there be a relationship between the ingredients in our diet, our eating habits and the incidence of gout?

Available evidences from various studies indicate that it is so. Low-purine foods like milk, cheese, eggs and cereals are safe because the exogenous source of purines is less in such a dietary regime. However, purine-rich foods such as liver, pancreas, meat and fish certainly add to the exogenous source of purines and may tend to increase the uric acid production over and above that produced in the body from endogenous sources, in spite of the feedback mechanism operating in liver. When we consume foods of animal origin the following problems arise:

- (1) As we ingest more purines through diet, more uric acid is formed in the body and its level may rise in blood; and
- (2) Acidosis may set in due to increased production of acids resulting from the breakdown of the high protein content of the diet. This makes the urate less soluble and interferes with its excretion resulting

in its accumulation in blood.

During this time, if the kidney function is also diminished, then the condition becomes aggravated. Non-vegetarians have a craving to take alcoholic beverages and alcoholics have special interest to take meat and other foods of animal origin. Both these increase acids in the body apart from raising the blood uric acid levels and thus pave the way to gout.

#### Alcohol and gout

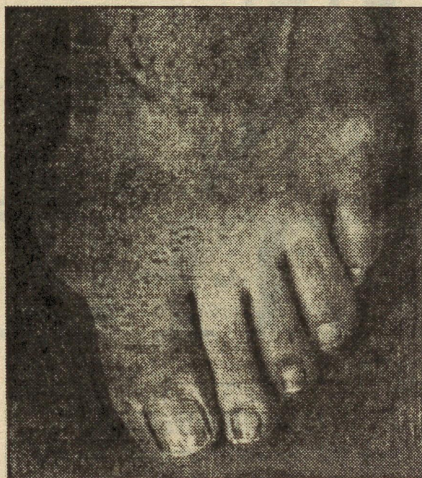
As the alcohol habit takes deep root and becomes chronic, symptoms of gout also start appearing. Alcohol tends to raise the blood lactic acid level and thereby decreases the alkali reserve. Consequently, the urine becomes more acidic and the solubility of urate decreases thus making its blood level higher. This helps its deposition in joints and leads to gout. Garrod, a famous physician of the nineteenth century, has mentioned in his classic book *The Nature and Treatment of Gout* (1859) regarding the role of alcohol in the incidence of gout: "There is no truth in medicine better established than that the use of fermented liquor is the most powerful of all the predisposing factors causing gout; nay, so potent it may be a question whether the malady would ever have been known to mankind had such beverages not been indulged in".

#### Control of gout

From the dawn of history, ever since the symptoms of gout were known to afflict man, it has always been his endeavour to treat and control this condition. However, if at all any satisfactory method of control or prevention of gout has been made possible, it has been only during modern times.

The classic treatment of gout has been ample bed rest, colchicine therapy along with restricted diet containing low-purine foods with intermittent use of sodium salicylate. Colchicine treatment, however, was found to have partial side-effects like diarrhoea, nausea, loss of appetite and vomiting. Colchicine is one of the non-specific anti-inflammatory drugs and it has no effect on the metabolism of urate or its secretion.

Salicylates, on the other hand, have the ability to solubilize urate and help its elimination in urine to a limited extent. If small doses of salicylates (1-2 g daily) are used, urate retention and not elimination is effected. Using a higher dose (5-6 g daily) is necessary to help the excretion of urate effectively in urine. Continuous use of this drug is not advisable as it may give opposite side effects.



In a sudden, acute attack of gout the skin becomes red and shiny. The veins on the top of the foot may be distended

Phenyl butazone, oxyphenbutazone and indomethacin are also given to patients with acute gout and are found to be very effective. All this may give rise to side effects like nausea, headache and vomiting; hence their intake has to be carefully regulated. When treatment starts, these drugs have to be taken in a higher dose (600 mg phenyl butazone + 150 mg indomethacin) and as the symptoms are found being relieved the dose has to be reduced accordingly.

Halofenate is a useful uricosuric drug (that helps eliminate uric acid in urine) that decreases uric acid deposits in the joints. Probenecid (benemid) is also equally effective. Since both these drugs have no bad side effects, they are safe and useful for long-term therapy. However, when these are taken, other anti-inflammatory drugs have to be taken side by side. Otherwise, instead of relief, the condition may become more acute. Sulphin pyrazone (anturan) is also equally effective and has

the advantage that the dose is less, viz., 0.4-0.6 g daily.

Allopurinol is an inhibitor of the enzyme xanthine oxidase and blocks the formation of uric acid from its precursor purines, xanthine and hypoxanthine. Administration of allopurinol helps decrease plasma urate levels and is useful in the therapy for gout especially if there is also renal insufficiency. On long-term therapy however, there is a danger that instead of uric acid, the sparingly-soluble xanthine may accumulate causing formation of renal "xanthine" stones and also other symptoms like dermatitis.

#### Is gout hereditary?

It is mentioned earlier that primary gout is hereditary. Two of the enzymes concerned with purine synthesis, viz., hypoxanthine-guanine phosphoribosyl transferase (HGPRTase) and pyrophosphoryl ribosyl phosphate synthetase (PPRP synthetase) are inherited from parent to offspring as X-linked recessive trait. These two enzymes show abnormal activities in gout and the defect may be passed on to males in the offspring since the inheritance is X-linked, and females will be carriers. As it may disappear in the subsequent offsprings if there are no consanguineous marriages between those affected and the carriers. A partial deficiency of HGPRTase and an overactivity of PPRP synthetase both can lead to overproduction of purines resulting in increased formation of uric acid and its excretion. PPRP synthetase can also cause resistance to the feed-back inhibition controlling purine synthesis in some types of gout. In a rare case of hereditary condition, called Lesch-Nyhan syndrome, there is a total deficiency of HGPRTase and the condition is very serious. This is accompanied by secondary hyperuricaemia and gout, cerebral palsy and self-mutilation tendencies to which the patient may ultimately succumb.

#### Pseudogout

Instead of urate, if calcium phosphate dehydrate (CPPD) is the material that accumulates in joints, it may

*Continued on p. 329*

Scientists are the last men to explain their method. But that does not mean that there is no such thing as methodology of science

# ON SCIENTIFIC METHOD

NILADRI S. KAR

"The feeling that the world is too complicated to understand is not uncommon in human history."

—Edward Teller

SCIENCE is a term derived from the Latin word *Sciens* meaning "to know". In its present sense, it is a kind of systemized knowledge, a set of consistent concepts about how everything works. It is surprisingly simple. It is universal and objective. The more sophisticated a scientific theory is the simpler will be its central concept, and the wider its applicability.

We can think of two phases through which science progresses: proposition of new theories and accumulation of facts. The first one simplifies the situation while the second makes the field crowded. Together, they swallow from the nature as much data as possible and

digest them, degrade them into a mosaic. The mosaic acts as a model, a miniature universe. Science does not tell you what the nature really is. It only describes a model, a masked reality. As our understanding becomes clearer and clearer, the gap

between the model and reality becomes smaller and smaller (Fig 1). The mask becomes thinner and thinner. But the crucial point is that the gap *remains*—no matter how much progress we make. There is no absolute truth in science. Scientific

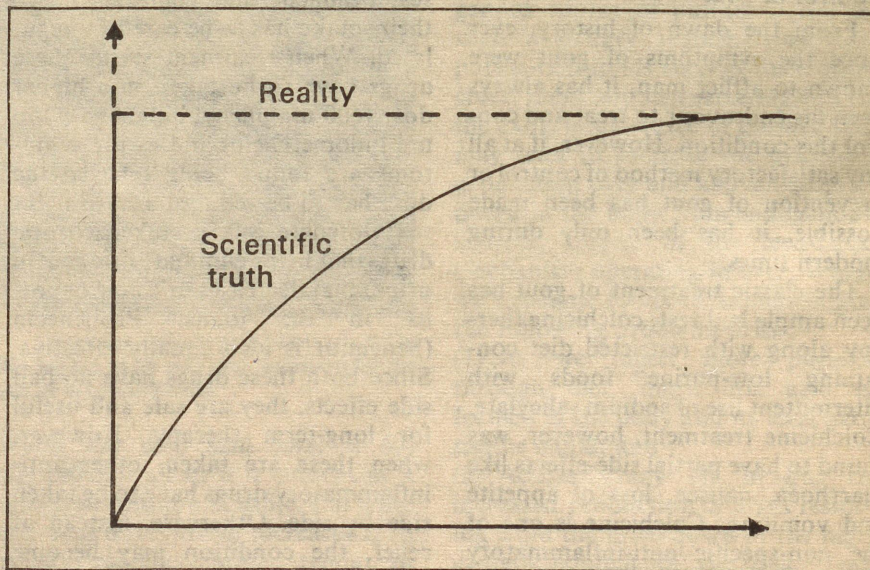


Fig. 1. Exponential growth of science. As science progresses, reality and our notion of truth become closer and closer. But they never meet

theories are always open to some questions. And that is the fundamental difference between a religious truth (or a myth) and a scientific truth. Between faith and logic. Between blindness and vision.

### Early methodology: Bacon

**"There is no procedure for anticipating the future of science, no 'science of science', and there are even scientists who argue that it is impossible in principle to do so.... I find their arguments unconvincing."**

—Gerald Feinberg

You may find it strange that the early methodologists of science were mostly non-scientists. Scientists proved to be the last men to explain *their* method. But that does not mean that there is no such thing as methodology of science. There does exist some overall scheme. It is followed by every scientist. Only (s) he does it unconsciously most of the time.

The most original and widely accepted methodology was due to Francis Bacon. Bertrand Russell elaborated and popularized Bacon's concept. According to this scheme, scientific method is composed of "three main stages," wrote Russell in his book *The Scientific Outlook*; "the first consists in observing the significant facts; the second in arriving at a hypothesis which, if it is true, would account for these facts; the third in deducing from this hypothesis consequences which can be tested by observation."

But unfortunately, the situation is not so simple. The method suggested by Bacon does not work. It cannot and *should not* be followed in a scientific investigation, because it does not take into account the dynamic relationship between theory and experiment. It does not explain the role of intuition. It is based on a wrong concept of *inductivism*. Here we cannot

either prove anything or disprove.

Let us take an in-depth look.

Russell spoke of "the significant fact." But what is *the* significant? What is not? Two apparently distinct facts may have a common explanation. An elephant is very stout and a polar bear has a very thick fur—these two facts are widely separated at the first sight, but both of them are due to warm-bloodedness. On the other hand, let's take another couple of facts: (a) an electric bulb emits light; (b) so does the sun. These are obviously similar, but the underlying principles are quite different.

The road from observation to hypothesis is also not a smooth one. There are blind alleys through which one might reach a pseudo-scientific (or non-scientific) concept. One might reach an absurd conclusion even through pure reasoning. Physicist Christiaan Huygens is the hero of one very peculiar story. Those were the days when Galileo just had announced his observation on Jupiter. He had reported four moons around the giant planet. Why four, asked Huygens, while we down here on Earth have only one? The conclusion he drew was this: *Jupiter is full of hemp*. His chain of reasoning was as follows. Well, what's the Moon for? For helping sailors at night of course. Four moons of Jupiter mean many sailors in the Jovian seas. Sailors mean ships. Ships mean sails. Sails mean ropes. And ropes are made from hemp. Jupiter must be full of hemp!

There are another kind of problems, problems concerning inductivism. To constitute a hypothesis from an observation we need to have a faith on the process of induction. We have to argue from the particular to the general. An inductive truth, however, cannot be proved by any logical reasoning. Actually the paths of discovery and justification are identical here. For example, let's take Newton's law of gravitation. How do we explain the fall of the apple? Of course, by assuming that Earth is attracting it. But why? Because Earth *attracts* an apple. Why? Because Earth attracts *everything*. Why? Because *everything* attracts every-

thing. This, the last sentence, is the central hypothesis. To get at it we have to perform a number of generalizations *without* any general observational support at each step.

Furthermore, once we obtain a hypothesis, we cannot test it. We have already done the necessary experiments. We have already gathered "the significant facts." The relation between reality and a Baconian hypothesis (or theory) is dull and oversimplified (Fig. 2).

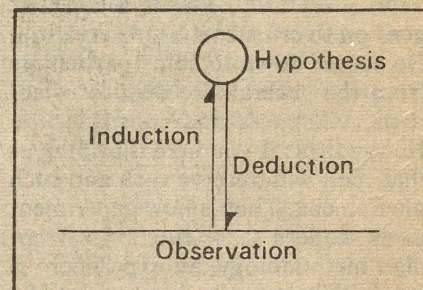


Fig. 2. Baconian system. A hypothesis is discovered through induction and justified through deduction. But these are only two opposite directions of the same road

### New methodology: Popper

**"... [Science], in its forward motion, is not logically propelled. Scientific reasoning is an exploratory dialogue that can always be resolved into two voices or two episodes of thought, imaginative and critical, which alternate and interact."**

—Peter Medawar

Early methodologists of science were reductionists, i.e., they believed in a completely logical structure of scientific process. Bacon, Newton, John Stuart Mill, Aldous Huxley—all of them denied the role of imagination. And that's the major problem with Baconian methodology.

A completely new concept develops from the works of William Whewell and others. Later, Karl Popper discussed this concept in details. It is

called *hypothetico-deductive method*. In this scheme, imagination and criticism merge into each other to a kind of synergism. A scientific theory starts from an imaginative venture. Hypotheses are not products of induction, but of adventurous journey of human mind. Here we have the romantic concept that truth takes shape in our mind. We possess a frame inside our brain, a preconception of what might be true.

After constructing a hypothesis (only, *after*, not before), a scientist goes on to criticize it by observation. He comes down to some particulars from the general. He deduces theorems, inferences and consequences. He predicts: if you take this thing or that, you will observe such and such phenomena. That is how experiment in its modern sense enters. In Baconian methodology, an experiment is an initial step in every scientific enquiry. It asks, "I wonder what would happen if....". In our new scheme, the role of experiment is quite different. Here we want to know whether our observation conforms to our hypothesis or not. Experimentation is a critical activity. This was the view of Galileo.

One important plus point of hypothetico-deductive reasoning is that discovery and justification work in two different pathways. This allows us to provide a real verification. Through negative feedback, we can constantly rectify our hypothesis. Verifiability of scientific conception is one of its major criteria.

Karl Popper, however, prefers "falsifiability" in the place of "verifiability".

There is an asymmetry between proof and disproof, he points out. While disproofs are conclusive, proofs are not. A discrepancy between prediction and observation implies that the hypothesis is to be rejected. But an agreement between these two cannot be taken to mean that the hypothesis is quite correct. A partially wrong thing is wrong, but a partially right thing is not necessarily right as a whole.

### Intuition

In the new methodology, intuition has a special place in scientific discovery. Intuition arises very suddenly, without any conscious chain of reasons. A flash and here it is! Just like an inductive hypothesis, it gives a generalized view. In the sense that it has no logical source of empirical truth, intuition is always a creative act of mind. Great theories of science start with gabbling thunders. "Eureka!", "Got it!"....

We all know how Kekule got the idea of cyclic structure of benzene. Our brain is a very complex science lab. Inside it we experiment with ideas, models, their consequences and alternatives, perhaps often unconsciously. The dream of the chemist about tail-eating snakes represents a fraction of such uncensored scenes. One of the greatest theories in the history of physics, the special theory of relativity saw the light of day through another such intuition. In his letter to Solovine, Einstein explained the birth of the revolutionary theory with the help of a sketch (Fig 3).

Like any other road, that of intuition is not without pitfalls. Blind faith—in your preconception or in other authority—may corrupt you. This is what happened to Kepler twice. For the first time, when he tried to explain the structure of the solar system using regular polygons. Only a few years later, he had to reject his idea of "Cosmic Mystery". For the second time, when he went on to express the number of satellites of the planets in terms of a mathematical series. Once again he had to retreat. He was left with "only a single cartful of dung," Kepler said in dismay.

### Theory and experiment

**"More often than not, it is the theory that comes first."**

—Richard Morris

Which comes first—theory or experiment? To historians of science, that is an intriguing question. However, in hypothetico-deductive system, it is certainly the theory that comes first. (Actually, it is hypothesis, the childhood of theory, that comes first). This brings special advantage for experimental scientists. For they no longer have to wonder "What would happen if...". Now they can laugh at those who claim to have verified velocity dependence of mass using grocer's scales. They can make little of those naked-eye observers who announce that there is no annual parallax of stars. The hypothesis to be verified always provides some clues. Even quantitative expectations can be deduced from it. A modern experimental scientist chooses his apparatus and expects a result being almost fully guided by the hypothesis. Theory is the blue-print of experiments.

What relative importances one should give on theory and on experiment? There are no prescribed clear-cut values. It all depends on style and style varies from scientist to scientist. Newton thought a scientist should always be guided by experimental

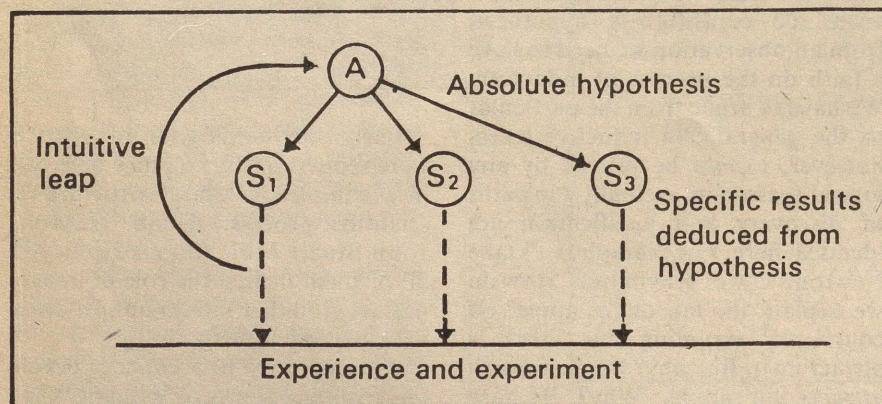


Fig. 3. Einstein's sketch of hypothetico-deductive system. Here discovery and justification are two completely different roads

data, he should not put forward any wild hypothesis. "*Hypotheses non fingo*", he said. Einstein, on the other hand, emphasized on theory, "... I hold it true that pure thought can grasp reality, as the ancients dreamed." Of course, these are but two rather extreme views. In general, the relation between theory and experiment is very dynamic and flexible.

To conclude, we have seen that science is not just a seven letter word. That it is not a junk store full of complex and acrobatic ideas. That scientists are not the crazy men and women who scribble something on the back of an envelope and get Nobel prize. That they are not the fellows who peer through some

'scope and cry out, "Hay! We've discovered an alpha to the power pi" or something like that. Scientists are not claiming that theirs is the true and the only possible view of the universe. What we have been trying to understand is that science progresses in a well-defined, self-correcting way and that scientists follow some general guideline of methodology. They help us to comprehend the universe around us, starting from a possible model and adjusting it, remoulding it, polishing it at every possible moment to bring us as close to the veiled reality as possible.

The veil is slowly fading away from over the face of a grand poetry called the cosmos. We shall never reach the last line.

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#### WHAT IS GOUT (Contd. from p. 325)

result in a condition similar to gout. This is called chondrocalcinosis. An X-ray study of the joints may reveal the condition. CPPD present in the synova and cartilage in microcrystalline form results in inflammation and pain in the joints. This condition is named crystal synovitis or pseudogout. Treatment of this condition is not easy and the drugs that are used for treatment of gout are not of any help. This condition may follow hyperparathyroidism and, is very rare.

Today, gout and gouty arthritis are not of much concern or fear among people. By proper regulation of routine and diet, one can go ahead in

one's everyday life with normal work. A knowledge about gout and how it can be regulated, controlled or treated may go a long way in helping the patient lead a care-free life without anxiety.

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#### Answers to quiz on vitamins

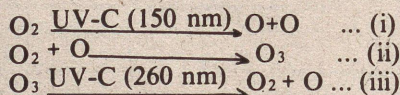
1. c; 2. c It contains PABA (para-aminobenzoic acid); 3. b; 4. d; 5. c; 6. d; 7. c, d; 8. b; 9. c; 10. b, c; 11. a, d; 12. b

# OZONE DEPLETION MEANS DANGER

A. HUSAIN  
P.C. JOSHI  
P.K. RAY

Ozone is a remarkably minor yet significant constituent of the upper atmosphere. It provides shield against damaging ultraviolet radiation and by absorbing solar radiation it becomes an energy reservoir of the upper atmosphere which is responsible for climatic regulation

**D**URING the course of evolution, plants used water (H<sub>2</sub>O) as a source of hydrogen (H<sub>2</sub>) for photosynthesis and released molecular oxygen (O<sub>2</sub>), which has subsequently accumulated to about 20% in the present environment. This created a highly efficient aerobic respiration system and also produced ozone (O<sub>3</sub>) in the stratosphere (Fig. 1) which protected us from the lethal short wave ultraviolet radiation (UVR). O<sub>3</sub> is produced in the upper atmosphere due to the reaction between molecular and atomic oxygen (O<sub>2</sub> and O respectively). O<sub>2</sub> upon absorption of far UVR forms O<sub>3</sub> as shown in (i) and (ii). O<sub>3</sub> can also decompose to O<sub>2</sub> and O (iii) and maintain a steady state concentration in the upper atmosphere.

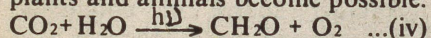


O<sub>3</sub> is a remarkably minor but significant constituent of the upper

atmosphere. It provides a shield against damaging UVR and by absorbing solar radiation it becomes an energy reservoir of the upper atmosphere which is responsible for climatic regulation. On the other hand, it is a lethal gas and its presence in the lower atmosphere produces deleterious effects in man as well as other organisms.

Since far-UVR striking the upper surface of atmosphere is biocidal, the protective O<sub>3</sub> umbrella makes life possible on the surface of earth. Without this protection, life on earth would have been virtually non-existent. The stratospheric O<sub>3</sub> layer varies reasonably in thickness between 2.4-2.6 mm at the equator and 3.1-4.3 mm at 70°N latitude. O<sub>3</sub> layer exists only because our atmosphere contains O<sub>2</sub>. Without O<sub>2</sub> it could not have produced O<sub>3</sub> and formed the protective O<sub>3</sub> layer. Without the O<sub>3</sub> cover considerable germicidal UVR would have crossed the atmosphere and reached the earth's

surface to disrupt the evolutionary process of life. Early life could have existed in the sea at a sufficiently low depth where lethal UVR cannot penetrate. Fossil evidence also suggests that life was not possible on earth prior to the formation of O<sub>3</sub> layer because the lethal UVR would have flooded the earth and killed all possible life-forming molecules on land. Only after the liberation of O<sub>2</sub> in the atmosphere by photosynthetic plants did the invasion of land by plants and animals become possible.



Between 200 and 290 nm range UVR is destructive to life but is efficiently absorbed by O<sub>2</sub> and O<sub>3</sub> in the atmosphere. It is mainly concentrated at an altitude between 15 and 35 km. Interestingly, O<sub>3</sub> levels are low over the equator and high near the

observed over Los Angeles (USA) is due in part to the reaction of O<sub>3</sub> with hydrocarbons emitted by automobiles. Oxidant level (including O<sub>3</sub>) greater than 0.15 parts per million can cause eye irritation in a significant portion of the population.

O<sub>3</sub> is a highly reactive molecule that can oxidise most of the organic compounds including some biologically significant molecules of the body. Higher O<sub>3</sub> level in air can produce lipid peroxidation and thus in a way could be responsible for pulmonary damage caused by smog. However, it does not contribute significantly to the environmental degradation of pollutants.

The penetration of light through skin has important consequences (Fig. 2). There is evidence to suggest that various types of skin cancer, par-

ditions like cloudiness, aerosol concentration, latitude, and the lifestyle of individuals particularly relating to their outdoor activities. Nearly 60% of the radiation from the sun responsible for directly producing redness and swelling of skin is received between 10 A.M. and 2 P.M. One way to protect against harmful effect of UVR is by simply avoiding direct sunlight exposure during the above period without much change in living habits. Based on present information on the relationship of UVR and skin cancer it is clear that: (1) depletion of stratospheric O<sub>3</sub> will result in an increase in radiation below 320 nm, (2) an increase in radiation below 320 nm will result in an increase in aging, skin cancer and other skin diseases, (3) the observed increase in the rate of skin cancer

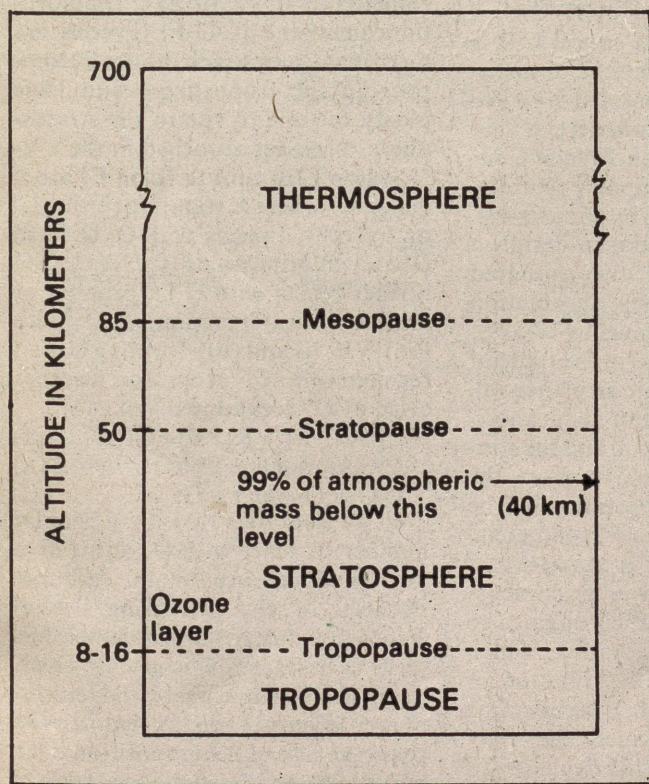


Fig. 1

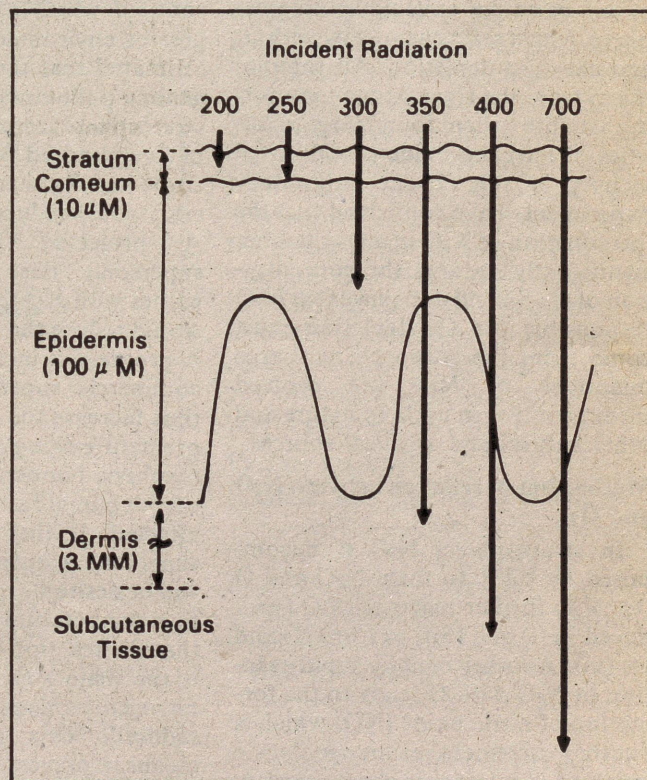


Fig. 2

poles. At sea level it is present in atmosphere only in traces (0.02 parts per billion). The blue haze that forms over some of the densely vegetated area is attributed to aerosols formed by O<sub>3</sub> oxidation of hydrocarbons released by plants. A similar effect

ticularly malignant melanoma, may be caused by cumulative exposure of radiation between 290 nm and 320 nm (UV-B). The risk of UV-B exposure is greatly influenced by the thickness of O<sub>3</sub> layer in the stratosphere and by other atmospheric con-

with decreasing latitude could be due to several interacting factors, of which O<sub>3</sub> thickness is the major one, apart from differences in local atmospheric conditions, genetic background of the population type, length and nature of outdoor activity, etc. It

is estimated that a 5% decrease in the stratospheric O<sub>3</sub> level increases the rate of skin cancer by 20%.

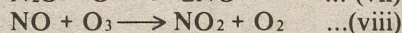
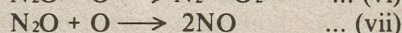
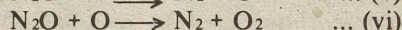
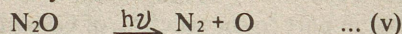
The solar UVR flux reaching the surface of earth is influenced by: (1) O<sub>3</sub> thickness, (2) scattering by atmospheric molecules, particles and aerosols, (3) attenuation by clouds, haze and smog near the ground (atmospheric pollution significantly decreases the penetration of UV-B), (4) seasonal variation, (5) air mass (maximum intensity of UVR between 10 A.M. and 2 P.M.), (6) altitude (about 4% increase in UV flux occurs with every 300 meter rise in altitude), (7) latitude, and (8) reflectivity of the ground (reflection by snow and sand increases UVR flux).

Experimental observations reveal that something other than the commonly known gaseous constituents of air must be existing in stratosphere, which react chemically with O<sub>3</sub> and cause its depletion. Air samples taken from the trace ozone monitoring satellite system found large quantities of nitrogen oxide (N<sub>2</sub>O) in the vicinity of O<sub>3</sub> layer. Laboratory experiments have confirmed that the introduction of N<sub>2</sub>O in a O<sub>3</sub> chamber significantly reduces the concentration of O<sub>3</sub>. Scientists believe that N<sub>2</sub>O responsible for O<sub>3</sub> depletion must come from the troposphere. Large quantities of N<sub>2</sub>O are evolved through nitrogen cycle in nature and other natural and artificial sources.

#### Mechanism of reaction between N<sub>2</sub>O and O<sub>3</sub>

In stratosphere, N<sub>2</sub>O is decomposed by UVR to form N<sub>2</sub>O and O (v). N<sub>2</sub>O further reacts with O [produced in (i) and (iii)] to form N<sub>2</sub> and O<sub>2</sub> (vi). Another equally rapid reaction of N<sub>2</sub>O with O leads to the formation of nitric oxide (NO) which is another extremely reactive molecule involved in numerous chemical reactions in the stratosphere (vii). NO preferentially reacts with O<sub>3</sub> by forming nitrogen dioxide (NO<sub>2</sub>) and O<sub>2</sub> and thus depletes the protective O<sub>3</sub> layer (viii). N<sub>2</sub>O further reacts with O to regenerate NO (vii). Generation of NO through a cycle of chain reactions (vii and viii) leads to continuous destruction of O<sub>3</sub> during every reac-

tion cycle.



However, in a pollution-free stratosphere O<sub>3</sub> concentration is regulated by N<sub>2</sub> cycle. A steady state is achieved between the input of N<sub>2</sub>O from N<sub>2</sub> cycle, the formation of NO from N<sub>2</sub>O, and the removal of NO (chiefly as nitric acid) by diffusion into the troposphere. As a result, O<sub>3</sub> level retains a steady-state concentration through a series of reactions involving its synthesis as well as breakdown.

#### Supersonic transports (SST)

Supersonic airliners that fly over stratosphere release various oxides of N<sub>2</sub> and carbon, particulate sulphates, uncombusted hydrocarbons, and soot, of which oxides of N<sub>2</sub> are of greater environmental concern. It is estimated that the amount of nitrogenous pollutants liberated into the stratosphere from a commercial fleet of five hundred British-French Concorde and Russian Tupolev type aircraft would reduce O<sub>3</sub> by about 3-4%. A projected American-designed supersonic fleet of five hundred planes with greater fuel consumption would reduce the O<sub>3</sub> layer by 17-18%. A progressive increase in the trade of commercial supersonic airplanes will thus increase the rate of skin cancer, premature aging of skin, and the stratospheric temperature. In short, the earth's climate and vegetation will be affected. If the use of commercial supersonic transport is necessary, it will be desirable to lower the combustion temperature in their engines so that the reaction of N<sub>2</sub> and O<sub>2</sub>, which is the main source of formation of nitrogen oxides in their exhaust, is reduced. This provides the only means to prevent further depletion of protective O<sub>3</sub> umbrella.

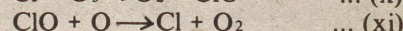
#### Nuclear tests/atomic bombs

There is concrete evidence to believe that nuclear tests performed by the USA and the USSR in the early sixties reduced the stratospheric O<sub>3</sub> concentration for several years. It is increasingly becoming evident that in an atomic war, apart

from the combatant casualties at the site of explosion, there would be worldwide non-combatant casualties resulting from the impairment of O<sub>3</sub> layer. American scientists believe that if half of the atomic arsenal of two major atomic powers are exploded, there would be a 50-70% decrease in stratospheric O<sub>3</sub> concentration which would result in more disastrous global effects than the lethal effects of ionising radiation.

#### Spray cans and refrigerator freons

Another source of pollutants, which is destroying O<sub>3</sub> layer, has been freons (chlorofluoromethane derivatives) largely used as propellants in spray cans and as refrigerants. Freons are obtained from methane by substituting chlorine (Cl) and fluorine (F) for hydrogen, the principal derivatives are dichlorodifluoromethane (CF<sub>2</sub>Cl<sub>2</sub>) and trichlorofluoromethane (CCl<sub>3</sub>F). Freons are inert molecules which do not decompose in the troposphere and have plenty of time to rise to the stratosphere. They get absorbed in the UV-C region (220 nm) to form Cl atom and CX<sub>3</sub> (where X stands for either Cl or F) (ix). Cl reacts with O<sub>3</sub> to form O<sub>2</sub> and chlorine oxide (ClO) (x). ClO further reacts with O [a product of photochemical reaction of O<sub>3</sub> with far UVR, (i) and (ii)], forming O<sub>2</sub> and regenerating Cl atom for another cycle of O<sub>3</sub> breakdown (xi).



F is also liberated in a similar manner to react with O<sub>3</sub> but it does not produce any chain reaction. Because of the increasing use of freons in industries and domestic life, their concentration is progressively rising in the troposphere and stratosphere. Scientists predict that in a few years the rate of decomposition of O<sub>3</sub> by freons may equal the rate of breakdown due to the operation of natural N<sub>2</sub> cycle in the stratosphere. They are also of the opinion that in all probability, freons will decompose O<sub>3</sub> in the stratosphere as effectively as under laboratory conditions. Yet very little efforts have been made by the regulatory agencies all over the world to control the

manufacture and use of freons. Volatile brominated compounds widely used in industrial processes should also be scrutinized for possible effect on  $O_3$ . Methyl chloride formed by fermentative microbes may also serve as another source of Cl that would pollute the stratosphere. Cl is also liberated from ammonium perchlorate, which is used as an oxidising agent in the rocket engine of space shuttle.

### Major consequences of $O_3$ depletion

$O_3$  layer protects us from lethal solar UVR. Even a small depletion in stratospheric  $O_3$  can pose major threat to all living systems. Further,  $O_3$  depletion would not only allow the penetration of more UV-B radiation but would also permit some solar UV-C to reach the surface of earth. This event would turn the geo-

logical clock back to an era when  $O_3$  layer covering the earth was much thinner. The total destruction of  $O_3$  layer would decimate life from the land areas of the earth. The damage caused by SSTs, freons and nuclear bombs would probably be so rapid that even microorganisms would not have any chance to survive. In the lower atmosphere a number of complex photochemical reactions would occur producing a variety of eye and throat irritants, and generate photochemically various lethal species as photochemical smog. A direct correlation has been found between cataract formation in eyes and UVR, microwave and ionizing radiation. Our skin and eye lens contain photosensitive chromophores which absorb UVR, generating reactive  $O_2$  species such as singlet oxygen ( $^1O_2$ ),

superoxide anion radical ( $O_2^{\cdot-}$ ), hydroxyl radical ( $\cdot OH$ ) and hydrogen peroxide ( $H_2O_2$ ). These species are known to elicit a photochemical response for cellular damage through several mechanisms (Fig. 3).

Major oxidants present in photochemical smog are  $O_3$ ,  $O$ ,  $\cdot OH$  and  $O_2^{\cdot-}$  which play significant role in the oxidation of hydrocarbons and conversion of NO to  $NO_2$ . Even though a direct correlation of the rate of increase in skin cancer with the rate of  $O_3$  depletion has been suggested by dermatologists, no one knows what would be the extent of damage to forests, crops, orchards, pollinating insects and the entire ecosystem. The sea and fresh-water life would be equally vulnerable to phototoxicity.

If the pollution of the stratosphere is continued by uninhibited flights of SSTs, and space shuttles and use of freons, the effects could be catastrophic. There is a need to initiate an international cooperation programme to curb the production of chemicals that are most reactive to  $O_3$ . Industries and governments must follow the recommendations of regulatory authorities and help combat the threat to our survival before it is too late. Our future lies virtually in our own hands. If we act now to preserve the natural identity of stratosphere, we may be able to ensure a pollution-free atmosphere for our future generations.

### Further reading

1. Giese, A.C., (ed): *Living with Our Sun's Ultraviolet Rays*, Plenum Press, New York (1976).
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4. Mitra, A.P., New horizons in upper atmosphere research, *CSIR News*, 30 March 1987.

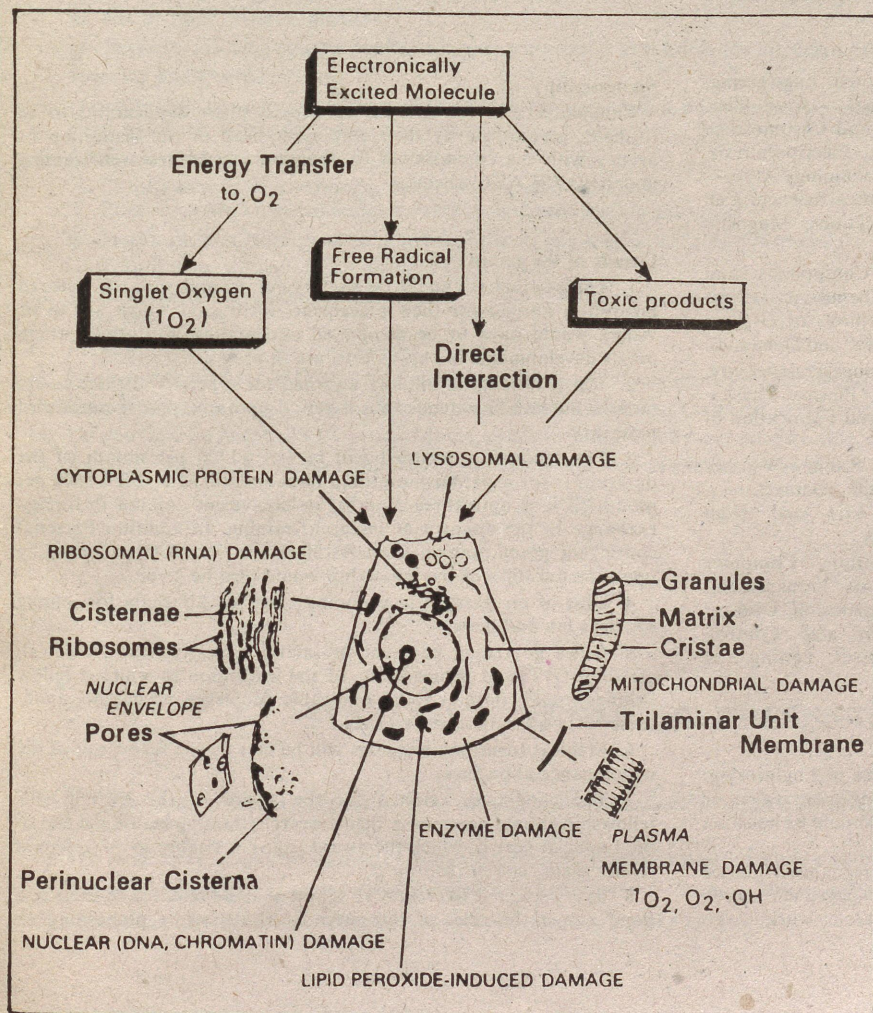


Fig. 3

S/Sh. A. Husain, P.C. Joshi and P.K. Ray are Scientists at Phototoxicology Laboratory, Industrial Toxicology Research Centre, M.G. Marg, Lucknow-226001

## Government of India

Ministry of Science and Technology  
Department of Science and Technology (DST)

### BOYSCAST FELLOWSHIP SCHEME : 1989-90

Applications are invited from Indian Nationals for the award of Fellowships under the programme "Better Opportunities for Young Scientists in Chosen Areas of Science and Technology" (BOYSCAST) for conducting advanced research or undergoing specialised training in overseas research laboratories/institutes in the following chosen frontline areas of science and technology.

**Life Sciences:**—Site Directed Mutagenesis and Protein Engineering, Macromolecular Crystallography, Monoclonal Antibodies, Carbohydrate Synthesis, Fluorescence Aided Cell and Chromosome Sorting, Chromosome Mapping and Pulse Field Electrophoresis, Computer Graphics and Molecular Modelling, Neurobiology Areas—Sensory Mapping; CNS; Brain Chemistry; Neuromedical Sciences; Cell Differentiation, Biomaterials for Medical Applications, Magnetic Resonance Imaging in Medicine, Photobiology.

**Chemical Sciences:**—Organometallics, Cluster Compounds and catalytic Applications, Photochemistry, Plasma Chemistry, Reverse Osmosis, Micelles, Marine Chemistry, Newer Methods of Organic Synthesis, Biomimetic Chemistry, Molecular Structure and Dynamics.

**Physical Sciences:**—High Temperature Superconductivity, Accelerator Physics, New Materials Technology, Plasma Physics, Photonics, Astronomy and Astrophysics—Design and Fabrication of New Types of Telescopes; Gravitation.

**Earth and Atmospheric Sciences:**—Medium Range Weather Forecasting, Geotectonic Models, Experimental Geotectonics, Thermodynamics of Multiphase Systems at Low and High temperatures, Hydrogeology/Mathematical Geology.

**Engineering Sciences:**—Robotics and Automation, Computer Integrated Manufacturing (CIM), Irrigation and Water Management, Advanced Materials, Encapsulation, Membrane Separation, Disaster Mitigation, Power Electronics, Instrumentation and Control, Advanced Mechanical Design, Production Processes, Testing and Quality Control, Precision Engineering.

#### Eligibility:

1. The applicant should possess a Masters degree in Engineering, Technology or equivalent or M.D. degree in Medicine or equivalent or Ph.D in Science and Technology or equivalent and should be less than 35 years of age (on the date of application).
2. The candidate should hold regular position in a recognised Science and Technology Institution and should be actively engaged in research work in the relevant area. Application from persons working on

temporary positions as Research Fellows/Associates etc. will not be considered.

3. Indian scientists and technologists who have established their credibility in the area based on which institutions abroad have expressed their willingness to accept them for training/research.

#### Sponsorship:

Candidates must be officially sponsored (their applications to be formally forwarded) by their employers/head of the institution or agency with the commitment to depute them for research/training under BOYSCAST scheme.

#### Details of the award:

1. The candidates should themselves correspond with the research institution abroad for their placement. Institution which are to be visited would have to be recognised outstanding institutions where major developments in chosen area are in progress.

2. The fellowship is initially awarded for a period of three to six months but can be extended for a period upto one year if considered necessary.

3. The fellowship awarded will be US \$1200 per month (if the duration is for a period more than three months) and US \$1600 per month (if it is upto three months) or equivalent amount in foreign exchange in the country of research/training. In addition Personal contingent grant ranging from Rs. 5000/- to Rs. 20000/- depending upon the duration of the fellowship would also be given.

4. Cost of air passage in economy class by Air India for joining overseas lab and back.

5. Rules governing payment of salary, seniority, leave, medical, gratuity, GPF and pensions etc. of the institution to which a fellow belongs would continue to be applicable. However, no liability under these rules will be borne by DST.

6. Medical Insurance expenses will be met by the fellow out of the maintenance allowance.

7. The candidates selected for the award of the BOYSCAST fellowship should commence their research/training before the end of the financial year in which the award is given. *Failure to do so would render them forfeit the award.*

8. Every selected BOYSCAST fellow shall be required to execute a bond as per the rules of the parent institute before proceeding on

fellowship and shall also be required to execute a service bond to serve in India for at least three years after return to India.

9. If the fellow does not return to India or gets a job opportunity overseas on completion of the fellowship, he/she will be required to reimburse the whole of the expenditure incurred on him/her during the fellowship period.

Candidates should submit their application typed on A-4 size plain paper. (Ten copies with single enclosures) in the format given below to the Secretary (Attn: SERC Secretariat), Department of Science and Technology, Technology Bhavan, New Mehrauli Road, New Delhi 110016 within 45 days from the date of publication of this advertisement.

### **FORMAT : Application for BOYSCAST Fellowship (1989-90)**

1. Name of Applicant, Designation and Address of the Institute
2. Date of Birth and Age
3. Academic qualifications (Bachelor's degree onwards with subject of specialisation and academic distinction, if any.)
4. Details of the nature and duration of the present and previous employment.
5. Brief summary on current areas of research
6. a) Number of research publications during last ten years (attach list excluding papers presented in conference, symposia etc.). Enclose reprints of not more than three publications which you consider best.  
b) No. of Ph.D students guided  
c) Details of training courses conducted, research projects granted to the applicant during last ten years
7. Honours and awards received
8. Overseas visits (include details like country and lab of visit, duration, purpose, degrees obtained, paper published etc. Exclude visits which are of less than one month duration)
9. Details of proposed training:
  - i. Chosen area in which training/research programme proposed.
  - ii. Brief summary of the training/research programme and its objectives
  - iii. Justification of its importance and relevance to ongoing/future programmes of the institution of the candidate.
  - iv. Future scope of application in India in that area
10. Proposed place of research/training (justify its selection and enclose consent of Overseas Host Institution alongwith facilities to be provided).
11. Proposed duration of the Fellowship.
12. Have you applied for BOYSCAST Fellowship previously? If answer is yes then details thereof.
13. Give details pertaining to other scientists/engineers and institutions engaged in the proposed subject of research/training.
14. Do you have an ongoing S&T project? If yes, please mention its reference number, title, duration, funding agency and cost.
15. Name of two Indian referees (with their addresses) in the field of the chosen area.

**Signature of Applicant**

*Place :*

*Date :*

### **STATEMENT FROM THE PRESENT EMPLOYER**

(This should mention about the continuity of the employment, deputation terms like leave, payment of salary etc. during the fellowship)

**Note :**

- (1) The candidates should themselves correspond with their proposed host institution abroad for placement.
- (2) The applications not sponsored and duly forwarded by the parent institution/organisation or received after the last date will not be considered.
- (3) Candidates who have applied earlier should apply again as per the format.

**davp 514/16/89**

## Microwave and ultrasound in chemical reactions

**I**NCOMPLETE combustion of a hydrocarbon flame has many disadvantages if such a flame is to be used for heating. The decomposition of soot on heating surfaces diminishes the rate of heat conduction, wastes fuel and makes the heating surfaces dirty.

In 1855, a burner called the Bunsen burner was devised to produce a sootless flame. So efficient was the design of the new burner that only minor changes have been made in it in the 133 years since its introduction. Even today it forms the most popular burner in chemistry labs.

Efforts have also been made to use various other forms of energy, for example, light, sound, etc., to promote chemical reactions. Microwave energy is a new addition to the field.

Chemists in Canada have used microwave ovens to speed up chemical reactions. Richard Gedye, Frank Smith and Kenneth Westaway of the Chemistry Department of Laurentian University, Ontario have reported (*New Scientist*, 19 May 1988, p. 38) that reaction rates can be increased by a thousand times by using microwave instead of conventional Bunsen burners. These researchers have verified the utility of the new technique using preparation of a typical compound 4-cyanophenyl benzyl ether. They investigated other types of reaction too and reported that using microwaves, reactions can also be brought about in sealed bottles. Pressure inside helps to raise the boiling point which in turn speeds up the reaction. The Canadian scientists carried out the reactions in Teflon bottles trans-

parent to microwaves.

The secret in chemistry lies in solvents. Gedye and others showed that rise and fall in temperature on exposure to microwaves depend upon the polarity and hence to dipole moment of the solvent molecules. They found that polar solvents help to raise temperature but non-polar solvents like carbon tetrachloride and n-hexane do not. But among the polar solvents there is no regularity in this respect. On exposure to microwaves for about one minute, 50 ml water reached 81°C, acetic acid 110°C, and dimethyl-formamide about 131°C. There are many reactions which can be carried out better by the use of high-intensity ultrasound. It is reported that efficiency of the reactions are better than those carried out by conventional means of heating or irradiating them either with ultraviolet or visible radiation.

Researchers of the University of Illinois, USA, have discovered that sound can stimulate many reactions without any difficulty and that these have likely industrial applications. The Illinois team at Urbana Champaign and led by Kenneth S. Suslick has speeded up catalytic action in some reactions by means of ultrasound thereby increasing the reaction rate. Iron pentacarbonyl is used as the catalyst to effect conversion of 1-pentene to *cis*- and *trans*-2-pentene. The Illinois scientists reported that the rate of conversion is significantly increased if the catalyst is activated by means of ultrasound.

Ultrasound activation has some advantages over heating. First, it does not require a long time for com-

pletion of a reaction. Most reactions can be carried out in a few minutes' time whereas the time required with thermal processes is high.

Another problem with thermal and refluxing processes is that the products are admixed with by-products and the yield of the major product is often low. Use of light energy in the induction of the reaction has similar disadvantages. Thermal processes are also frequently followed by decomposition of the products and reactants leading to a drop in the yield of the product. These difficulties can be overcome if ultrasound is used as the source of energy.

An important application of ultrasound lies in saponification of esters. Esters undergo hydrolysis on boiling with alkali. But there are reports that in presence of high-intensity ultrasound, esters yield acids with the same yields in a few minutes' time as obtained by boiling the ester with alkali for a few hours.

Hydrolysis of different esters such as methyl benzoate, methyl 2, 4-dimethylbenzoate, methyl 3, 5-dimethylbenzoate with alkali in presence of ultrasound gives the same quantity of the corresponding acids as obtained when hydrolysis is brought about by refluxing with alkali.

The Illinois scientists further reported that besides reducing reaction time, the yield may also be increased by increasing the duration of irradiation with ultrasound. They reported that while yield of 2, 4-dimethylbenzoic acid is 15 per cent when saponification is brought about by irradiation with ultrasound for 10 minutes the yield is 90 per cent when irradiation period is one hour.

It has been further reported that ultrasound can catalyse several industrial reactions including isomerisation and hydrogenation better than conventional heating.

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## Metallothioneins act as detoxifiers in animals and plants

**T**HE heavy metals like zinc, copper, cadmium, lead, silver, mercury, nickel and cobalt are minor but an ubiquitous component of the biosphere. Zinc and copper, which participate in a variety of enzymatic reactions, are essential trace elements for all life forms but are toxic when present at inappropriately higher concentrations. The other ions serve no known physiological function and are generally considered as toxic heavy metals.

Certain varieties of crop plants as well as weed species have been reported to be resistant to heavy metal pollution. The resistance mechanism to heavy metal pollution has been investigated by a large number of workers in lower as well as higher plants. In biological system cysteine-rich low molecular weight proteins play an important role in sequestering the available toxic heavy metals and thereby detoxifying the cellular environment. These cysteine-rich metal binding proteins

are known as metallothioneins (or metal chelators) which lack enzymatic functions.

• Metallothioneins comprise a class of low molecular weight cysteine-rich metal binding proteins, the first of which was isolated from equine renal cortex (Margoshes and Vallee, 1957). Metallothioneins bind heavy metals through a cluster of thiolate bonds and the strength of binding depends on the nature of the ion. Its biosynthesis is homeostatically regulated in cells when organisms are exposed to salts of cadmium, zinc, copper and mercury (Kagi and Vallee, 1961, Swiss). The characteristic features of metallothioneins are—

- (1) high content of cysteine and paucity of aromatic and hydrophobic amino acids;
- (2) low molecular weight (typically less than 10,000 daltons);
- (3) maximum electronic absorption at 254 nm and less absorption at 280 nm;
- (4) high content of heavy metals

(typically 4-12 atoms/mol) bound exclusively by cluster of thiolate bonds; and

(5) its functioning as a detoxifying agent by sequestering toxic metals.

Metallothionein is a metal inducible protein which itself binds Cu, Zn, Cd and Hg. In animals, several investigators have characterized metallothioneins from kidney, liver, heart, testes and cultured cells in man. Such a type of proteins have also been isolated from plants and microorganisms and characterized. In recent years metallothionein-like cadmium binding complexes have been identified in several higher plant species. These observations suggest that metallothionein like proteins may be involved in heavy metal resistance in higher plants as in animals.

### Structure of mammalian metallothionein

The most significant structural data provided by  $^{113}\text{Cd}$  NMR has demonstrated that the 7 moles of bound  $\text{Cd}^{2+}$  are arranged in two separate metal clusters, one containing four metal ions and the other containing three, with all  $\text{Cd}^{2+}$  tetrahedrally coordinated to cysteine thiolate ligands (Fig. 1). It is evident

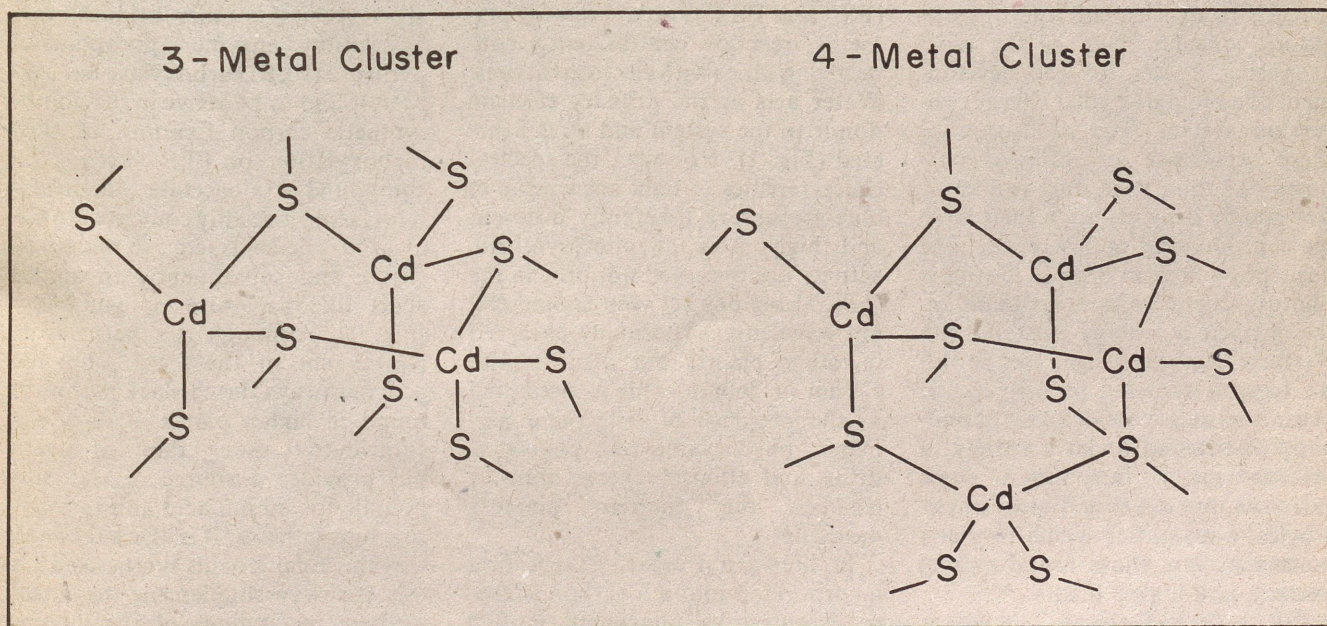


Fig. 1. Structures of the 3-metal and 4-metal clusters in mammalian mt. based on  $^{113}\text{Cd}$  NMR data

from the structural studies that metallothionein is exquisitely designed to bind heavy metals in cooperative fashion and that the protein can adopt varied conformation in response to different classes of ions.

#### Genetic engineering and metallothioneins

The aim of genetic engineering is to evolve organisms that overproduce desirable gene products. Metallothionein (MT) synthesis is regulated in biological system by specific genes. Increase in the rate of MT gene transcription is mediated through interactions between upstream regulatory DNA sequences and unidentified cel-

lular factors. Metallothionein gene (MT gene) is also induced in some mammalian cells by glucocorticoids, interferon and stress condition. Induction of heavy metal resistance could very well be considered in susceptible crop plants by increasing the number of copies of genes coding for metallothioneins through genetic engineering manipulations.

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## Photosynthetic carbon assimilation in blue-green algae

**B**LUE-green algae (Cyanobacteria) are a simple group of photosynthetic micro-organisms considered to be a link between bacteria and plants. Their potentiality as an alternative energy source has been recently recognised and some investigators consider them as the most promising agents for the development of a biological solar energy conversion system. The utilization of these organisms for different purposes like food, feed, fuel and fertilizer greatly depends upon their large scale production at low costs. The basic physiological process for this is photosynthetic carbon assimilation, the principal energy metabolism. Further, blue-green algae are the oldest oxygen evolving photosynthetic organisms and are widely and abundantly distributed under a variety of environments including some extremes. In fact, they display physiological capabilities which in many respects surpass those found among bacteria and higher plants.

For carbon skeleton blue-green algae, like other autotrophic organisms, mainly depend upon the pho-

tosynthetic carbon assimilation. The energy required for the process is derived from light energy (solar energy). Like in higher plants, in these organisms also solar energy is trapped through two photosystems (PS I and PS II) (with accessory pigments, reaction centres, etc.) connected in series with electron carriers. Water acts as the primary electron donor to the system and  $O_2$  is liberated (Fig. 1). However, the spectral characteristics of light absorption in blue-greens are inherently different and high rates of photosynthetic activity are observed not only in the spectral regions between 665nm-680 nm wavelengths (normally observed in other plants) but also around 620nm or 560nm. This is attributed to the presence of biliprotein pigments, phycocyanin and phycoerythrin, and efficient energy transfer between the different pigment molecules.

In blue-green algae,  $CO_2$  is first incorporated into a 5 carbon acceptor Ribulose bis phosphate (RuBP) in presence of an enzyme RuBP carboxylase using energy. The product

splits into two molecules of a 3 carbon compound phosphoglyceric acid (PGA). The reduction of PGA, mediated by the electron carrier NADPH (nicotinamide adenine dinucleotide phosphate), leads to the formation of a series of sugar phosphate intermediates and finally to glucose. The primary acceptor RuBP is also regenerated (Fig. 1). This pathway, known as Calvin cycle (reductive pentose phosphate pathway), is considered to be evolutionarily primitive and is universally present in all photosynthetic plants. The primary carboxylating enzyme of this cycle, RuBP carboxylase, is relatively inefficient and in blue-greens it is present in large quantities (20%-30% of total cellular protein), some part of which is packaged in special bodies called carboxysomes (polyhedral bodies). On the other hand, these organisms show low photorespiratory rates (release of  $CO_2$  in light), low  $CO_2$  compensation points (where photosynthetic uptake of carbon dioxide is equal to respiratory  $CO_2$  release), low carbonic anhydrase activity, etc., which are uncharacteristic of Calvin cycle (or  $C_3$ ) plants.

Recently, in several blue-green algal species another primary carboxylation enzyme, phosphoenol pyruvate (PEP) carboxylase has also been found to be active in the photosynthetic carbon fixation. In this, carboxylation of PEP yields a  $C_4$  compound oxaloacetate. Oxaloacetate (OAA) is readily converted to  $C_4$  dicarboxylic acids, e.g., to malate or citrate and subsequently to amino acids like aspartate or glutamate (Fig. 1). Although this pathway is reminiscent of the  $C_4$  dicarboxylic acid pathway (Hatch-slack pathway) found in higher plants, it does not contribute to the synthesis of sugars but provides a source of  $C_4$  compounds for amino acid and tetrapyrrole biosyntheses. It is also suggested that the organic acids synthesised via this pathway supplement the intermediate metabolites of the incomplete respiratory cycle found in these organisms.

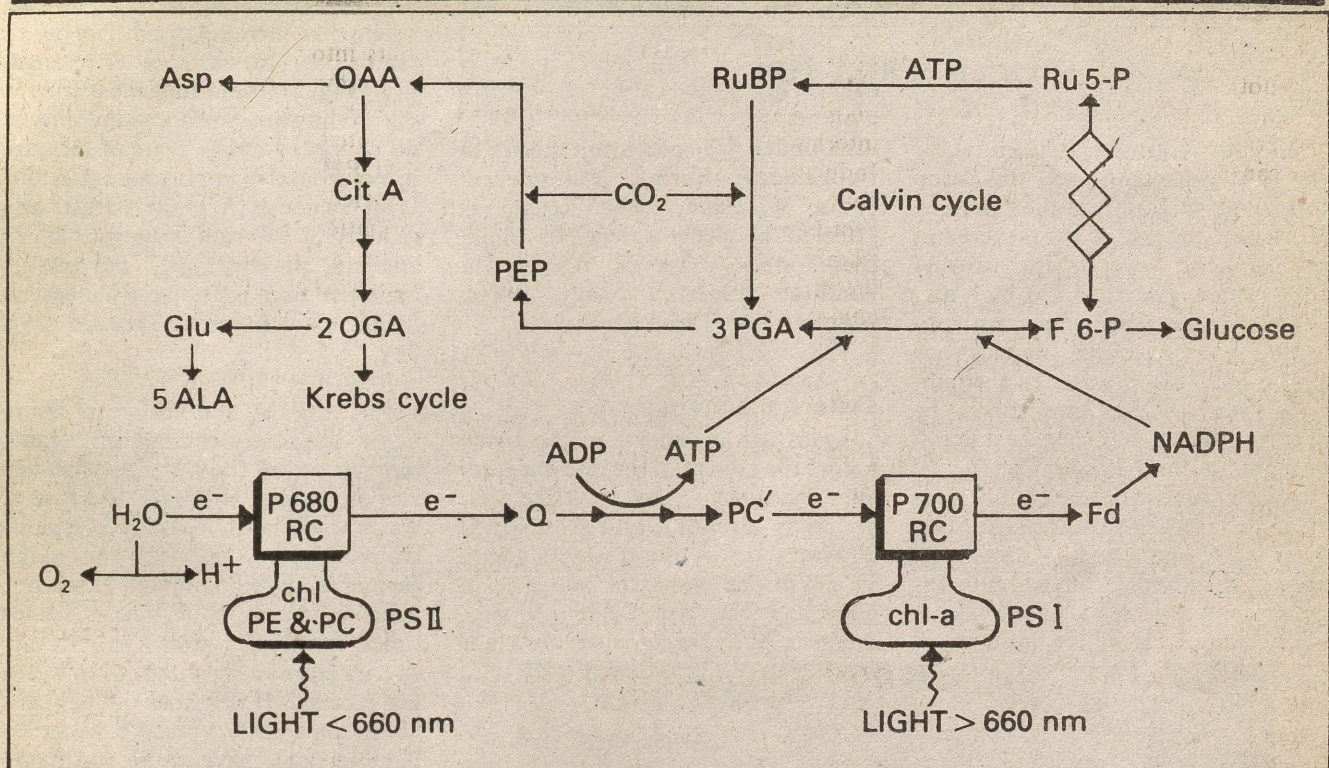


Fig. 1. Photoassimilation of carbon in blue-green algae (cyanobacteria); Chl: Chlorophyll; PE: Phycoerythrin; PC: Phycocyanin; P.C: Plastocyanin; PSII: Photosystem II; PSI: Photosystem I; RC: Reaction centre; Q: Quinone; Fd: Ferridoxin; ATP: Adenosine Triphosphate; ADP: Adenosine diphosphate; NADP: Nicotine amide adenine diphosphate; F-6-P: Fructose 6-Phosphate; Ru 5-P: Ribulose 5-Phosphate; Ru B P: Ribulose 1, 5- Bisphosphate; 3 PGA: 3-Phosphoglyceric acid; PEP: Phosphoenol pyruvate; OAA: Oxaloacetic acid; Cita: Citric acid; 2-OGA: 2-Oxoglutaric acid; Asp: Aspartic acid (family); Glu: Glutamic acid (family); 5ALA: 5-Aminolaevulinic acid

The possession of two carboxylating systems, operating side by side, may represent an important adaptation of blue-greens to rapidly changing environments. The differential activities of these two enzymes under differing environmental conditions are reported in several blue-green algae. Colman, B and others (1976) of York University, Canada showed 1.5 to 5 fold higher activity of PEP carboxylase to RuBP carboxylase in three species of blue-green algae. E.R.S. Talpasayi and B.P. Narasimharao (1986) of Banaras Hindu University, Varanasi found difference in carbon metabolism in the same alga from pond (nature) and from culture; the activity of RuBP carboxylase compared to that of PEP carboxylase being more in the former than in the later. A.J. Smith of University College of Wales, Aberystwyth (U.K.) has suggested that the PEP carboxylation reaction in blue-greens is an essential route for synthesis of certain metabolites. It can be

said that in blue-green algae under limiting light conditions carbon assimilation is preferentially channelled towards the synthesis of amino acids and other essential constituents, but under sufficient light, sugars and starch are formed via the reductive pentose phosphate pathway.

Another important adaptation of blue-greens which may increase their photosynthetic efficiency is lack of photorespiration, where RuBP carboxylase acts as an oxygenase releasing CO<sub>2</sub> from organic compounds. Different mechanisms like bicarbonate transport into cells to increase internal carbon dioxide concentration at the carboxylation site (bicarbonate being dissociated with the help of an enzyme called carbonic anhydrase), packaging of RuBP carboxylase in carboxysomes (thus protecting the enzyme from oxygen), endogenous refixation of carbon dioxide liberated due to photorespiration in the algal cells, excretion of glycolate (an intermediate of the pho-

torespiratory cycle) are suggested to explain the low photorespiratory rates observed in these organisms.

It India, blue-green algae are at present used as algal biofertilizer in the rice fields and use of these organisms in other fields like fish aquaculture, cattle feed, waste water reclamation, etc., has also received much attention recently. The photosynthetic carbon assimilation in these organisms shows special features to adapt to changing environments. A better understanding of the process will be helpful to evolve efficient and economically feasible biotechnology programmes involving these organisms.

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## Deep water rice

**P**LENTY of water is essential for rice cultivation as this crop thrives in shallow standing waters. However, excess of water creates problems. In several rice growing areas water level rises too high and completely inundates the crop subjecting it to a severe submergence stress. Such 'deep water rice' conditions prevail where water cannot be drained off and stagnates to a depth of 0.5m-5m for 3-10 months (Fig. 1). Ordinary rice varieties cannot survive this submergence stress. Specific deep water rice varieties having an ability to elongate under submergence conditions are planted in such areas. About 11 million hectares of

area under rice cultivation mostly in Bangladesh, Burma, Kampuchea, India, Thailand and Vietnam is affected by deep waters. In India, these areas exist as pockets in Andhra Pradesh, Assam, Bihar, Manipur and Tamil Nadu.

### Culture of deep water rice

Seeds are broadcast in the fields before the advent of the rainy season. When sufficient rains soak the soil, the seeds germinate and grow for 4-20 weeks before flood waters come. When floods come the water level rises and the rice fields get submerged. As the water rises the plant

height also increases gradually due to internodal (between joints) elongation (Fig. 2). Plant tops must emerge out of the water surface as inability to do so means death. Rate of increase in water level is important as the survival chance of the plant is drastically reduced if the rate is more than 25 cm/day. Interestingly, rice plants have also been reported to increase in height by as much as 20cm-25 cm a day.

The tug of war between rising water levels and elongating plants may go on till the water level stabilizes or recedes. However, increase in water level should cease before panicle emergence as after this stage further elongation of plant axis is not possible. Deep water rice is sometimes known to attain heights up to 7 m. Harvesting is done after water has receded. If this does not happen, as in some early duration varieties, panicles may have to be top harvested from a boat.

### Varietal improvement

Deep water rice yields are 0.5-2 T/ha which is very poor as compared with 5-7 T/ha of the high yielding varieties. However, it is important to bear in mind that in most deep water rice areas no other crop can be grown. As such the subsistence of the local population is greatly dependent on the success of this crop. Further, common agronomic practices like fertilizer application cannot be profitably applied in standing waters to improve yields. Therefore varietal improvement through hybridization is important. Some important morpho-physiological characters for which breeding programmes aim at are: seedling growth vigour, tillering ability and drought tolerance during the early establishment stage; rapid internodal elongation capability in even 3-week-old seedlings; development of adventitious roots from upper internodes to draw more nutrition from flood waters; and large air cavities through the stem for inducing buoyancy. Some important Indian hybrid varieties superior to



Fig. 1. An experimental deep water rice field (Photograph source: : International Rice Research Institute, Los Banos, Philippines)

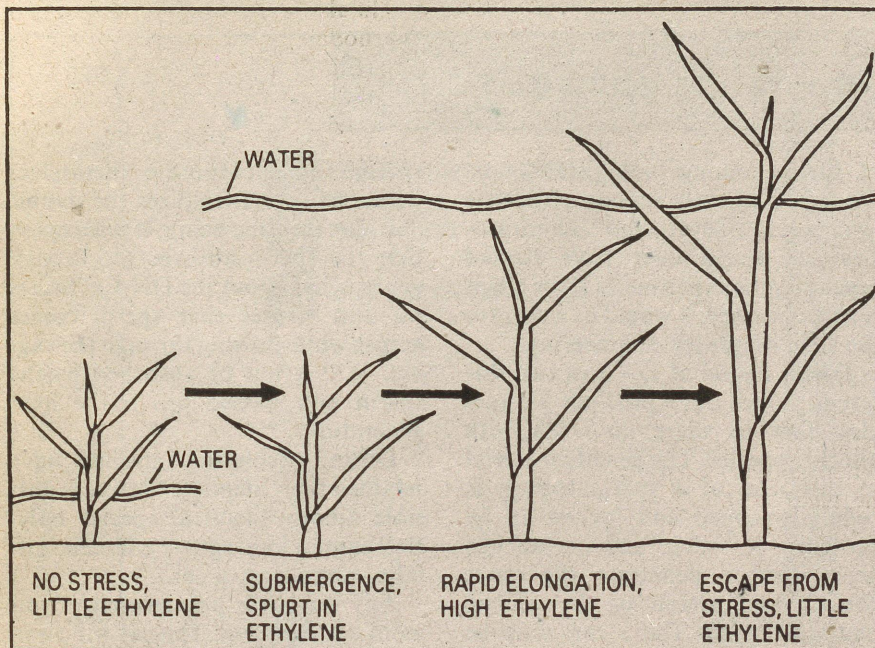


Fig. 2. Elongation behaviour of deep water rice upon submergence and accompanying ethylene production

the local types are Jaisuria, Jaladhi-1, Jaladhi-2, Jalmagna, and PLA-2. Jalmagna is known to withstand 6-8 m of deep water.

**Physiology of shoot elongation**

The physiology of rice shoot elon-

gation during submergence stress is well investigated. An important event following complete submergence of plants and preceding elongation is a spurt in the production of the gaseous plant hormone ethylene within about 30 minutes (Fig. 2). Interestingly, ethylene production

stops soon after leaves protrude above the water surface. Ordinary rice varieties that do not possess this elongation ability fail to show any marked increase in ethylene production upon submergence. A.A. Khan of the New York Agricultural Research Station, New York, has put forward a hypothesis to explain the mechanism of submergence stress alleviation by ethylene (Fig. 3). Ethylene biosynthesis is initiated from the amino acid methionine (MET) via intermediates S-adenosylmethionine (SAM) and 1-aminocyclopropane-1-carboxylic acid (ACC). Application of aminoethoxyvinylglycine, a specific inhibitor of ACC synthesis, during submergence stopped ethylene production and elongation. All these observations point towards the fact that ethylene is not merely a by-product of the elongation physiology but is specifically involved in the process.

The growth hormone gibberellic acid-3 (GA) brings about shoot elongation in plants through reserve food mobilization, osmoregulation, cell elongation and antagonism of the natural growth inhibitor abscisic acid. Tetracyclase, an inhibitor of GA biosynthesis, strongly inhibits elongation in deep water rice. This inhibitory effect can easily be reversed by external application of GA. Thus the primary role of shoot elongation of deep water rice is ascribed to GA. Under stress-free conditions moderate GA action leads to normal shoot elongation (Fig. 3). Submergence stress stimulates ethylene production from ACC. According to Khan, this production and action of ethylene leads to the removal of an 'inhibitory block' that permits much higher GA activity and consequently rapid shoot elongation. Thus submergence stress alleviation by ethylene, although essential, only indirectly brings about the elongation response through enhanced GA activity.

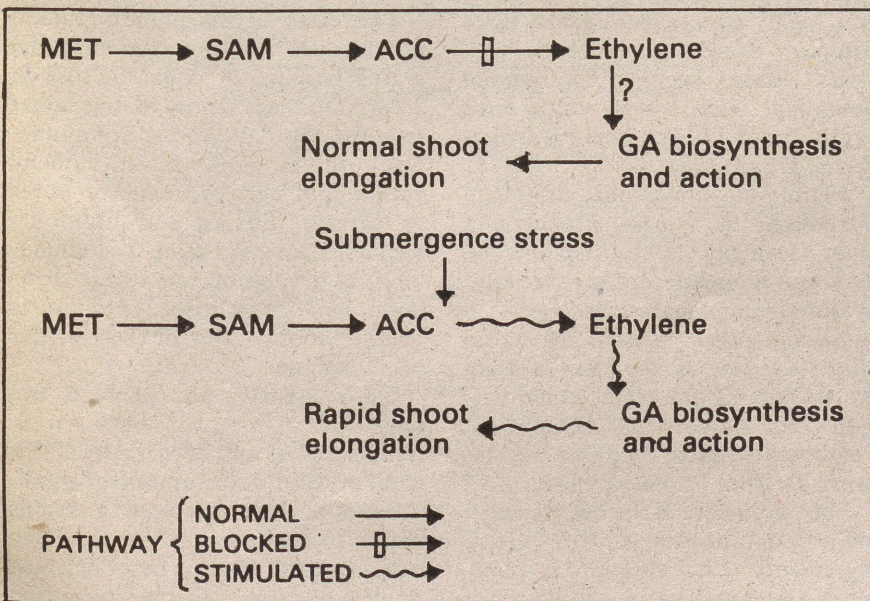


Fig. 3. Schematic representation of submergence stress alleviation by ethylene through enhanced GA action. Note that the role of ethylene in normal shoot elongation is not well established

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## Incorporating genes directly

**I**S it possible to introduce directly genes from one species into the sperm of another species? Yes. This is what an article published a couple of months ago in scientific journal *Cell* by a team of scientists from University of Rome claims. The Italian scientists say that when to the sperm of a particular species of mouse was added the genes of another species, the former soaked up about 4000 DNA molecules of the latter within 15 minutes. On fertilization of the mouse eggs in the test-tube with the treated sperm, the genes of about 30% of the newly born mice were said to have the new DNA permanently incorporated into them.

The report created the same degree

of furore among biologists as was witnessed recently among physicists in regard to "Cold fusion". Laboratories the world over have started repeating the experiment. If the claim is substantiated, it would be a boon in the field of genetic engineering.

Direct fusion of DNA of two different species is not possible. No species likes to share its DNA with another species. The genetic material in the head of a spermatozoon is tightly wrapped and locked up by proteins. As such, any extraneous genes cannot penetrate the outer coating and attach to the genetic material inside. There can only be one possibility. The foreign genes may attach to the outer surface of the

sperm and incorporate themselves when the sperm fertilizes the ovum.

If, for the time being, it is accepted that the sperm absorbs the foreign genes, what about the DNA of bacteria and viruses that sperm comes across while passing through the vagina. Will it not be absorbed by the sperm and passed on to the next generation?

During evolution species have retained their identity. Mating is possible among identical species only. Bull cannot impregnate a female buffalo, nor a dog, a cat.

Any way, it is premature to comment on the claim. The cat will soon be out of the bag.

C.B. Sharma

## How to avoid aluminium phosphide poisoning

**A**MONG various methods of pest control in storage use of insecticidal fumigants is an effective technique. The basic principle underlying the deployment of a fumigant is that it kills the pests in its vapour form leaving behind hardly any traces of the chemical applied at the recommended doses. For this reason, fumigation is preferred to admixing a contact, non-volatile insecticide with the grain as per the Prevention of Food Adulteration Act (1954).

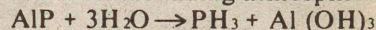
Aluminium phosphide, ethylene dibromide, ethylene dichloride-carbon tetrachloride (3:1 v/v mixture) and methyl bromide are some of the important fumigants registered for use in storage in India. The use of methyl bromide is restricted mainly to plant quarantine purposes and bulk treatment in ships, and is not suitable for common use in a tropical climate due to its gaseous nature. Aluminium phosphide is by far the

cheapest and effective fumigant and easy to handle among all fumigants. It is highly insecticidal against three common stored grain pests, viz., lesser grain borer (*Rhizopertha dominica*), rice weevil (*Sitophilus oryzae*) and khapra beetle (*Trogoderma granarium*).

Aluminium phosphide, originally introduced by Werner Freyberg in West Germany, is continued to be used as a fumigant for the protection of stored grains against insect pests in India and other parts of the world alike. It is sold in the form of 3 gm tablets and 0.6 gm pellets under various trade names such as Celphos, Fosfume, Quikfos, Synfume, Chemfume, Delicia, Phostoxin, etc.

The commercial products normally contain about 56% active ingredients, i.e., aluminium phosphide along with varying amounts of ammonium salts and alumina. Normally, 2 tablets per ton of grains are

sufficient for complete protection from insects. Each tablet costs 50 paise only. Aluminium phosphide is effective in controlling insect pests due to release of toxic phosphine (PH<sub>3</sub>) gas through a chemical reaction with moisture present in the grains or surrounding atmosphere.



The release of phosphine is gradual provided the moisture content of the grains is more or equal to 10% at 25°C. Decomposition of the tablet requires about 36 hours. Simultaneously, the ammonium salt, namely, ammonium carbamate decomposes to carbon dioxide and ammonia which help in combating the flammability of phosphine and also in slowing down its release. The tablets liberate about 1/3rd of their weight of phosphine.

Unfortunately, phosphine is not only toxic to insects but also to human beings and cattle. Any accidental or wilful consumption of aluminium phosphide may lead to serious health hazard or sometimes even to instant death. Several cases of phosphine poisoning have been reported in recent years especially from northern India. Table 1 lists the cases of

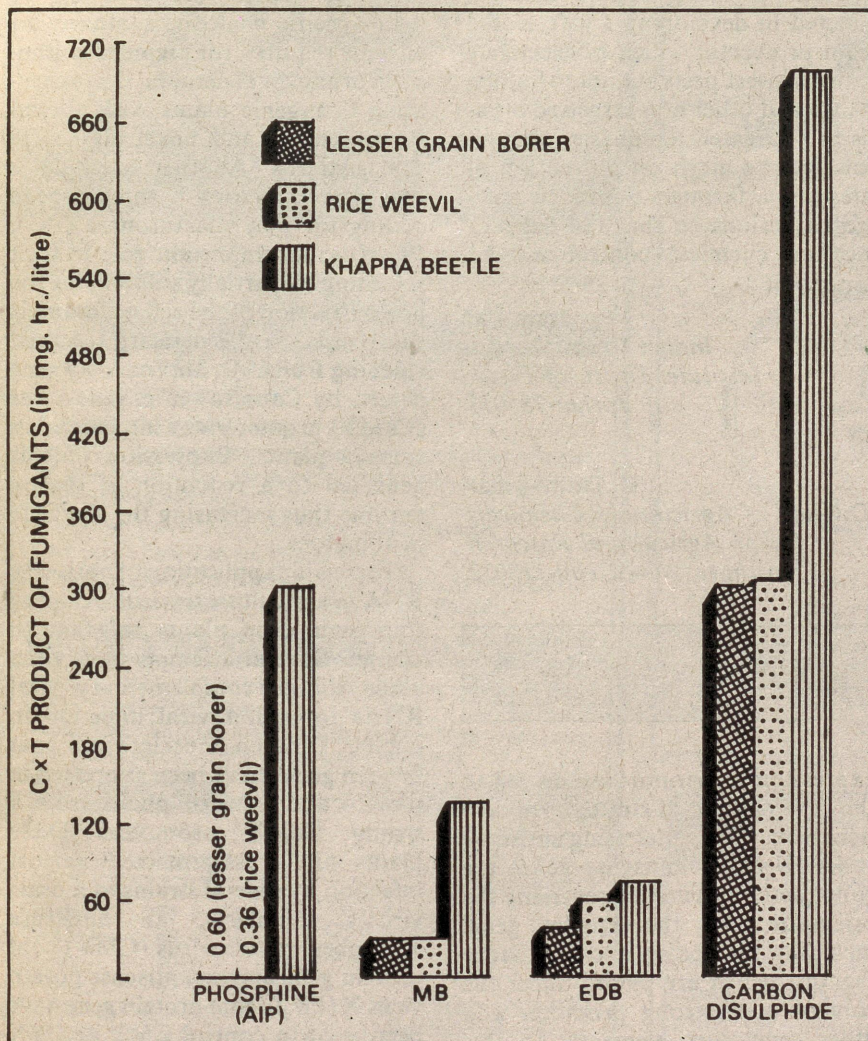


Fig. 1. Insecticidal capacity of different fumigants

phosphide poisoning in the world in chronological order. Excepting a single instance of attempted suicide in West Germany in 1967, all the cases

abroad were related to the accidental exposure to phosphine vapours. On the other hand, We have only reports of suicides in India.

Table 1. Case history of poisoning due to aluminium phosphide

Year of report	Country	Details
1964	Australia	Exposure in seaboard terminal due to bulk wheat fumigation with AIP; affected several victims, no death
1967	West Germany	One case of attempted suicide.
1967	Polland	Exposure to the fumigation of corn.
1976	Belgium	2 children died while playing on the piles of fumigated wheat.
1980	U.S.A.	2 children and 29 out of 31 crew members aboard a grain freighter became acutely ill due to exposure of PH <sub>3</sub> from wheat. One child died.
1985-86	MP, Rajasthan, Haryana (India)	Several cases of suicides and poisoning due to swallowing of AIP.

Symptoms of poisoning

Symptoms of aluminium phosphide poisoning include fatigue, buzzing in ears, nausea, pressure in chest, intestinal pains, diarrhoea and vomiting in case of slight to mild poisoning and dry cough, choking attacks, intense thirst, reeling gait, severe pain in limbs, enlarged pupils, rapid onset of stupor, in addition to the above symptoms, in case of medium to severe poisoning. In case of phosphide poisoning, clinical observations reveal myocardial damage as the major cause of death which occurs even with a small dose within 6 hrs of ingestion. (Even ingestion of 0.6 gm pellet could cause death within 4 hrs).

First aid

The most useful first aid is to help the victim to induct immediate vomiting, and stomach washing should be done with dilute potassium permanganate solution. Injection of Digoxin (0.5 mg) appropriately diluted and administered intravenously, followed by one tablet of Digoxin orally, is reported to have saved the life of the victim. On inhalation of phosphine, various types of cardiac arthmias, toxic myocarditis and peripheral circulatory failure have been observed. It is, therefore, mandatory to avoid occupational hazard by limiting its concentration to 0.3 ppm as the prescribed threshold limit value with time weighted average of 40 hr/week in air and 1 ppm as the threshold limit for short term exposure of 15 minutes.

From the above accounts, it is seen that PH<sub>3</sub> is toxic to human being. PH<sub>3</sub> is an unwanted byproduct in metallurgy. It is also a doping agent to treat silicon crystals in the semiconductor industry. It is estimated that about one million workers in the USA alone are exposed to PH<sub>3</sub> every year. One should, therefore, avoid exposure to phosphine but the AIP has been so formulated that it is safe for use in storage bins. We do not have really an equivalent fumigant which can match AIP in terms of cost, ease to use and efficacy. It is

valuable further because of its outstanding ability to penetrate into the bulk of the grains, and its toxicity to stored product pests. In addition, it has no appreciable effect on stored product and leaves no appreciable permanent residue in the produce. Indulgence in suicidal/unlawful ingestion of AIP is no fault of AIP at all but only that of the user and peculiar social compulsions of the victim.

Several agencies both in Government and private sectors are engaged in training workers and farmers in various levels on the safe use of these chemicals. In addition to these on going programmes, intensive campaign through media for the proper use of these fumigants should be launched so that none becomes a victim due to ignorance. Long term

research planning should also be directed in developing a safe stored grain protectant which is selectively toxic to insect pests but not to human beings and other non-targetted organisms. Greater emphasis should, however, be given on prevention of infestation through improved storage conditions so that the dependence on chemical control will be minimized.

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RNA to suppress the synthesis of petal-specific chalcone synthase, an enzyme required for pigment synthesis in ornamental petunia, thus generating transgenic plants with altered flower colour and novel pigmentation patterns. Another example is that of inactivating a tomato gene coding for polygalacturonase (PG). PG plays an important role in fruit softening by partially solubilizing the pectin fraction of the cell walls and is synthesized in the pericarp tissue of ripening fruits. An antisense pg gene driven by Cauliflower mosaic virus (CaMV) promoter was introduced in tomato plants. Expression of this gene led to a reduction of the pg enzyme thus increasing the shelf life of tomatoes.

The major application of antisense RNA in agriculture lies in developing transgenic crop plants resistant to viruses. Several attempts have been made to use complementary viral RNAs to inhibit viral infection in plants. Tobacco mosaic virus coat protein genes have been expressed in tomato and tobacco plants from a strong CaMV promoter. These plants are cross-protected against infection by several strains of mosaic viruses. Similarly, an antisense cucumber mosaic virus (CMV) coat protein gene and an antisense potato virus X (PVX) coat protein gene have been used to control CMV or PVX infection in transgenic tobacco plants.

Although, at present, antisense RNA technology is beset with certain limitations, the fast progress being made in this field holds a bright promise for better crops in the near future.

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### Antisense RNA

**O**NE of the recent and most promising applications of genetic engineering in agricultural biotechnology is antisense RNA technology. This technique is based on blocking the flow of information from DNA via RNA to protein, by the introduction of an RNA strand complementary to part of the sequence of the target messenger RNA (mRNA). As a result of this, an RNA duplex is formed between mRNA and antisense RNA. Subsequently, the duplex is either rapidly degraded, or the mRNA is impaired in nuclear processing or it is blocked for translation.

Antisense genes were initially discovered in prokaryotes. These genes direct the synthesis of RNA which can directly control gene expression in a very specific manner. The finding that antisense RNA can inhibit gene

expression in natural systems led to the development of strategies to artificially regulate genes using antisense RNA. Usually, antisense genes are constructed *in vitro* by reversing the orientation of the known gene, including the coding and regulatory regions, which are placed under the control of a strong promoter and other regulatory elements. In this way antisense RNA can be used to make mutant cell lines of any organism. In eukaryotes, direct microinjection of antisense RNA (synthesized *in vitro*) into cells has resulted in specific inhibition of gene expression.

In plants, antisense RNA is most effective when selective reduction of tissue-specific expression at certain stages of development regulated by a specific promoter is required. One such example is the use of antisense

#### Corrigendum

Ref : S.R., June 1989, "Vitamin C protects eye lens from radiation damage";  
author's name on p. 303 : Read V.K. Srivastava For V.K. Sharma

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[Est : 75]

By Hasan Jawaid Khan

## New compounds dramatically affect cell growth

**N**EW therapeutic compounds developed by a Scotland firm have been successfully tested on injured animals and offer great promise for the treatment of human patients with arthritis or recovering from burns, serious wound or plastic surgery. The compounds have been shown to have a dramatic effect on the growth of animal tissue cells. Particular success has been seen in tests on competition horses suffering from acute tendon strains—generally recognised to be one of the commonest causes of such animals' disability and

slaughter. Over 30 horses with these disorders have been successfully treated with the compounds, with an overall high percentage recovery rate and a more rapid return to top performance levels over other treatments being achieved.

Other tests have suggested that one of the compounds could be used to avoid some of the side effects suffered by human cancer patients undergoing chemotherapy. Another compound which promotes healthy nail growth will be of great interest to the lucrative cosmetics industry.

## Tanning process reduces pollution

**A**N Australian-developed tanning process that removes hair rapidly from cattle hides and reduces pollution flowing from tanneries has proved successful in commercial trials. Called Sirolime, the process was developed by the Australian Commonwealth Scientific and Industrial Research Organisation's (CSIRO) Division of Wool Technology in Melbourne.

In conventional tanning worldwide, about 90 per cent of hides for

leather are treated by a process which chemically degrades the hair. Hair and chemical residue, which form soluble proteins and intractable sludges, make up about 80 per cent of pollution from tanneries. Sirolime precesses hides more cleanly and enables the hair to be used as a by-product—as a fertiliser or for other uses. But the major benefit is the reduction in pollution that tanneries produce.

## Vitamin E boosts immunity in old age

**W**ITH ageing comes a let-down in immune responses. Vitamin E in the diet can stimulate some of the flagging responses in old men and women, say scientists of the Human Nutrition Research Centre on Ageing at Tufts University in the USA. In experiments on 2-year-old mice (a ripe old age for mice), their immune systems responded as good as young mice when they were fed vitamin E at 18 times the recommended dietary allowance for 6 weeks. Another compound, glutathione, effected a similar response. But in both cases the

immunity was not restored to the level of young animals.

In a study on 32 men and women, all over 60 years of age, 16 took 800 I.U. vitamin E daily for a month while the other half got a placebo. About two-thirds of the volunteers fed on vitamin E supplements showed improvement in immune cell functions. However, there was no improvement in antibody production. The men and women taking supplements averaged 3 times more vitamin E in their plasma after the 30-day trial.

## Rats in space!

**A** *Cosmos* satellite which took to space in October 1987 had on board a few rats as its passengers. After 12 days in space the bones of the rats lost up to two-fifths of their strength. The rats returned with weakened muscles, suppressed immune systems, and a drop of 60 per cent in production of a growth hormone. These were some of the results of the 28 experiments made on the effects of microgravity on mammals presented at NASA's Ames Research Center in Mountain View, California. The results indicated that countermeasures including regular exercise and treatment with hormones would have to be taken by humans involved in prolonged space flight.

On *Cosmos*, humerus bones of the rats became 40 per cent more brittle and the strength of the vertebrae in the spinal column decreased by 27 per cent. Fluid accumulated between muscle fibres of the rats. Mitochondria in the heart muscle degenerated and skeletal muscles shrank in size. Proportions of helper and suppresser-T cells changed in the blood, thereby weakening the immune system. Levels of cholesterol and triglycerides increased while size of testes and magnitude of sperm production decreased.

In both the studies vitamin E increased the levels of interleukin-2 which promotes growth of certain infection-fighting white blood cells, at the same time it decreased levels of prostaglandin E, which has the opposite effect. Of the 4 immune cell types, T cells are the hardest hit as one ages. These were the cells that responded to vitamin E. But excessive use of vitamin E should be avoided without medical supervision, say the scientists.

## Nuisance weed disposes of nuisance pest

ONCE considered a nuisance weed, water hyacinth has added one more property to its list of beneficial qualities, that is, insecticidal potential. Scientists at the Regional Research Laboratory in Hyderabad have isolated a compound from the extract of the aquatic weed. This compound kills the rice moth (*Corcyra cephalonica*) at the larval

stage at a dose less than a millionth of a gram. The team of scientists headed by Kaiser Jamil observed that the larvae first became black, then exuded their body fluids and finally died before reaching the pupal stage.

Larvae treated with even a crude extract of water hyacinth died or developed into deformed adults lacking the ability to procreate.

According to Jamil, the extract contains sterols that have the potentiality to disrupt the growth and reproduction of the rice moth. The compound extracted from water hyacinth could thus be very useful in combating rice moth which is a serious pest of stored grains.

## A candle that filters water

THE Central Glass and Ceramic Research Institute (CGCRI) has developed a cheap ceramic water filter candle. Its low cost is an asset in rural areas where water-borne diseases claim innumerable lives every year. A water filter candle is a hollow cylinder made of porous ceramics. It is fitted in a chamber made of porcelain or metal, which in turn is kept on another chamber. Tap

water or well water is filled in the upper chamber.

The candles developed at the CGCRI have proved effective in filtering suspended matter and bacteria injurious to human health. The Institute has also developed candles for community use in schools, offices and other community centres. These candles filter about 6 to 7 litres of water per hour as against

2 litres per hour in candles for domestic use. Having been made from indigenously available common ceramic materials, the candles cost only Rs 34 as against Rs 70 for commercially available candles. The Institute is testing with still cheaper materials that would bring down the cost of the candle to Rs 10.

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## Workshop design aspects of EHV-UHV transmission lines

**T**HE Central Power Research Institute (CPRI) is a premier national organization engaged in Research & Development in the field of Electrical Power Engineering for the last 28 years. It is also an independent testing and certification authority for electrical power equipment.

The workshop to be held on 5 and 6 October 1989, aims at providing the engineers in the power utilities, academic and research institutions and manufacturers of UHV equipment, a forum to exchange views on the electrical and mechanical design aspects of UHV transmission lines. It covers the following topics:

(a) State of art of EHV-UHV Electrical design aspects covering: (i) corona and radio interference; (ii) field effects; (iii) overvoltages and

protection; and (iv) external insulation.

(b) Mechanical design aspects covering: (i) recent trends in transmission tower designs; (ii) foundation design practices; (iii) field investigation; and (iv) vibration aspects of conductors & maintenance, etc.

The faculty will consist of well-known experts in the field, specialised in the UHV technology from reputed organisations. **The last date of registration is 20th September 1989. For further details, write to:**

V.B. Ram Mohan  
Co-ordinator  
Workshop on EHV-UHV  
Transmission Lines  
Central Power Research Institute  
Post Box 1242, Bangalore-12

## Tenth International Lead Conference

**T**HE Tenth International Lead Conference—Pb90—will take place at the Acropolis Convention Centre in Nice from 29 to 31 May 1990. Organised by the European Lead Development Committee comprising lead associations and information centres in Belgium, France, Germany FR, Scandinavia, Spain and the United Kingdom, Pb90 will continue the successful series of lead conferences which began in London in 1962.

As on previous occasions, the Conference will bring together lead producers and consumers from around the world as well as many others interested in the future of the metal to discuss technology, research and markets for lead. The impact of general economic conditions and of environmental concerns will also be a

focus of attention. There will be simultaneous interpretation into French and English throughout the sessions. An exhibition will be held in an area adjacent to the conference room in the Acropolis Centre throughout the Conference and there will be a sightseeing programme taking in some of the main attractions of the Cote d'Azur for accompanying persons.

A programme and registration form will be issued shortly. Further details are available on request from:

Indian Lead Zinc Information  
Centre  
No. 7, Shopping Centre  
Block B-6, Safdarjung Enclave  
New Delhi-110029  
Phone: 600973, 604230

## MEDICAL NOTES

### Retinitis pigmentosa: an inherited cause of blindness

**W**HEN a person moves from a bright environment into a dark environment initially he can see nothing, but within a few moments the surroundings become faintly visible to him. This improvement in vision is due to considerable increase in the sensitivity of the retina, especially in the peripheral region, and is

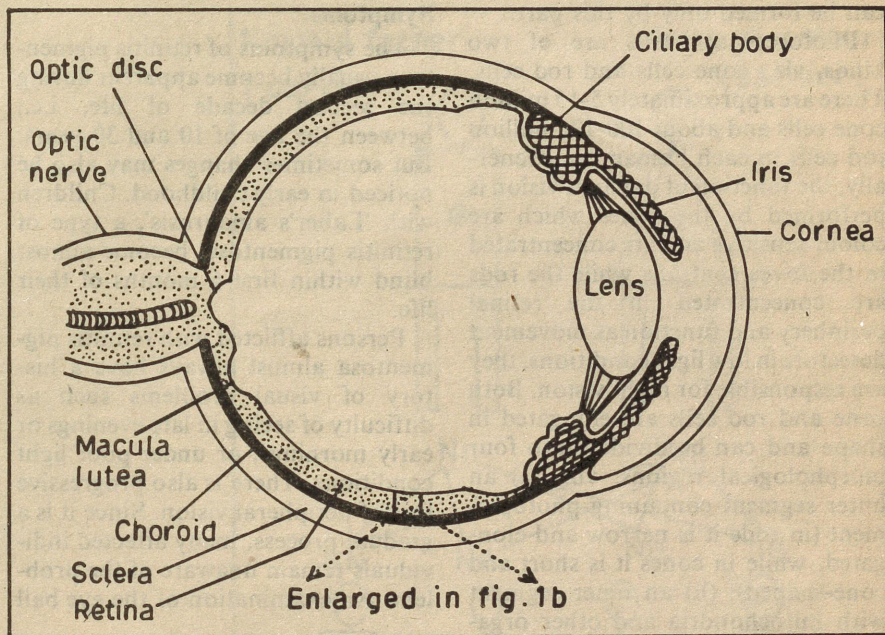


Fig. 1 (a). Horizontal section of the eyeball

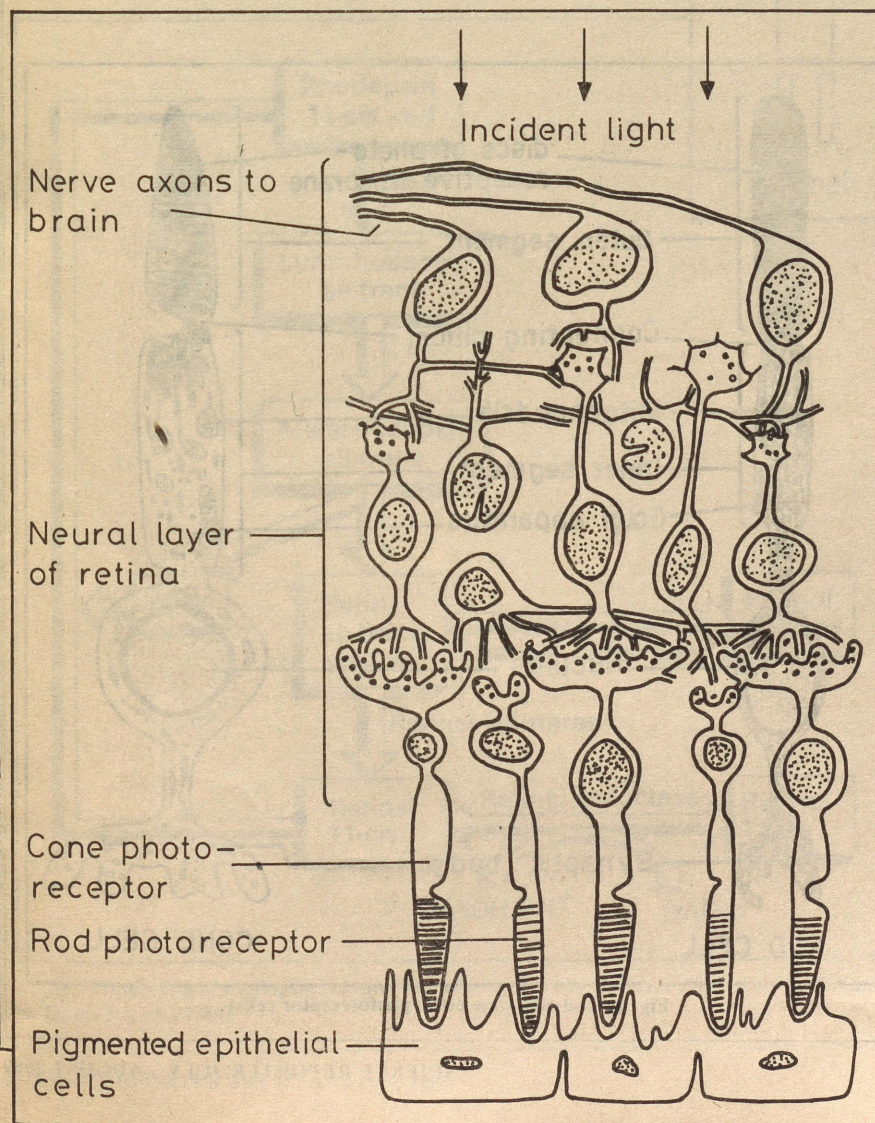
called dark adaptation. However, some persons are unable to see in the dark due to disturbances in this dark adaptation (scotopic vision) and are called 'night blind'. Night blindness is also an initial symptom of an eye disorder known as retinitis pigmentosa.

Retinitis pigmentosa is an inherited disorder which is still non-curable and is responsible for the largest class of genetically blind persons in any community. The only possibility of its prevention is through timely genetic counselling.

#### Retina

Retina—the layer at the back of the eye—is a highly sensitive membrane. It is formed of many layers of nerve cells and nerve fibres lying on pigmented epithelial cells which attach it to the choroid. The most light-sensitive layer of retina is that composed of photoreceptor cells. There is a small depression in the posterior part of the retina called macula lutea. In the centre of this area lies its most sensitive part called fovea centralis. A sharp visual image

Fig. 1 (b). Human retina showing association of rod and cone cells



## MEDICAL NOTES

can be formed only by this part.

Photoreceptor cells are of two kinds, viz., cone cells and rod cells. There are approximately 5-15 million cone cells and about 100-120 million rod cells in each human eye. Generally, the function of daylight vision is performed by the cones which are colour sensitive and are concentrated in the fovea centralis while the rods are concentrated in the retinal periphery and function as movement detectors in low light conditions; they are responsible for night vision. Both cone and rod cells are elongated in shape and can be divided into four morphological regions, viz., (i) an outer segment containing photopigment (in rods it is narrow and elongated, while in cones it is short and cone-shaped); (ii) an inner segment with mitochondria and other organelles; (iii) a nuclear zone; and (iv) a synaptic zone.

The optic disc or blind spot is the area of retina which has no light-sensitive cells (Figs 1a, 1b & 2).

### Photopigments

Both rod and cone cells contain photopigments which contain two types of compounds, viz., retinal (retinene), a derivative of vitamin A; and opsin, a protein. Opsins are different in rod and cone pigments. The cone photopigment is known as iodopsin and is composed of retinal and cone opsins. Cone opsins are of three kinds and are responsible for colour sensitivity. The rod photopigment is known as rhodopsin and is made up of retinal and scotopsin. It is a red pigment and is also known as 'erythropsin' or 'visual purple'. It plays an important role in low-light vision such as at dusk and dawn. Erythropsin gets bleached when exposed to light due to its conversion into opsin but regains its colour in the dark (Fig. 3). It is due to this bleaching of its photopigment that rods cannot be stimulated in light. The regeneration of rhodopsin in the dark is responsible for the dark adaptation (scotopic vision) and its non-regeneration may be the cause of night blindness.

### Symptoms

The symptoms of retinitis pigmentosa usually become apparent during the second decade of life, i.e., between the age of 10 and 30 years. But sometimes changes may also be noticed in early childhood. Children with 'Lager's amaurosis', a type of retinitis pigmentosa, become almost blind within first 6 months of their life.

Persons afflicted with retinitis pigmentosa almost always have a history of visual problems such as difficulty of seeing in late evenings or early mornings, or under poor light conditions. There is also progressive loss of peripheral vision. Since it is a gradual process, many affected individuals remain unaware of the problem. An examination of the eye ball

with an ophthalmoscope, however, reveals the disorder. The fundus, instead of showing uniform orange red colouration, shows black or dark brown star-shaped patches known as 'black blotches' in the neural retinal layer. During late stages of the disease, the fundus also shows thinning of retinal vessels. Sometimes the patches are also seen clumped around blood vessels in the mid-periphery of the fundus.

### Genetics of retinitis pigmentosa

Retinitis pigmentosa shows different patterns of inheritance in the affected families. Its transmission to the next generation occurs as a result of single defective gene(s). The most

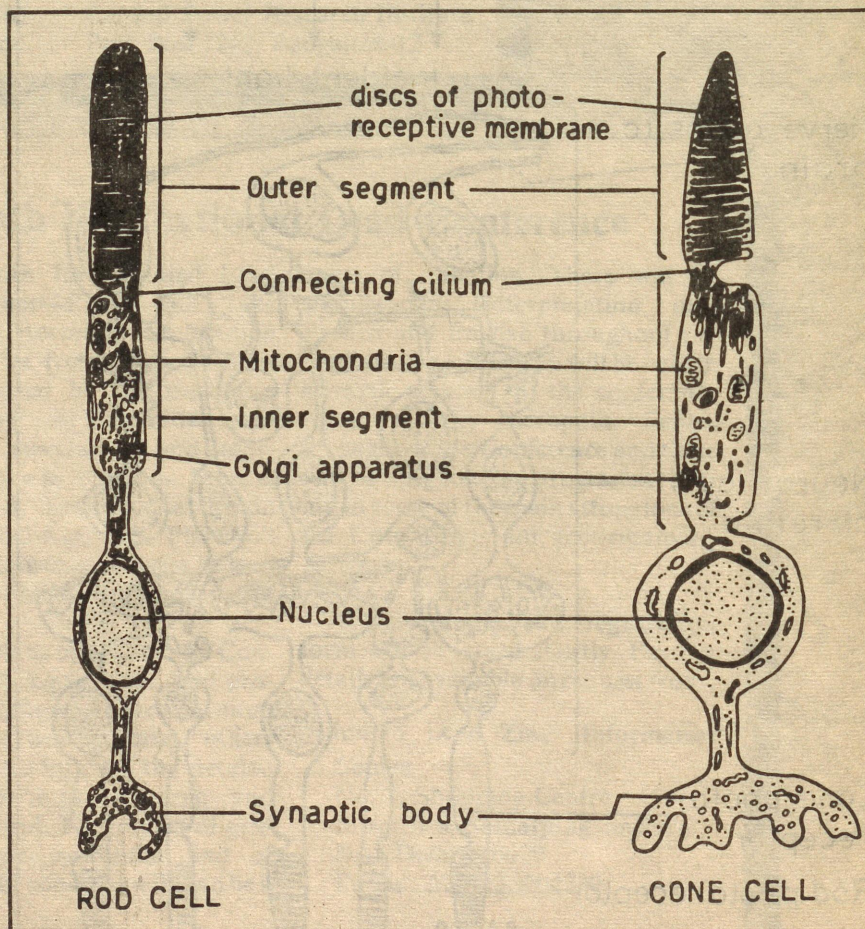


Fig. 2. Rod and cone cells (photoreceptor cells)

## MEDICAL NOTES

frequent pattern of inheritance of the disease is autosomal recessive and it accounts for 80-90% of all the cases, although this percentage varies significantly in different countries. In this category, both parents of an affected individual are normal but are carriers of the 'defective gene'. Their children are of three types, viz., normal, normal-unaffected carriers, and affected individuals. Both sexes are equally affected and the disease can occur in families with no previous history of this disease (Fig. 4a).

The second most frequent mode of inheritance of retinitis pigmentosa is autosomal dominant. In this case, at least one parent is similarly affected and from this affected parent, it

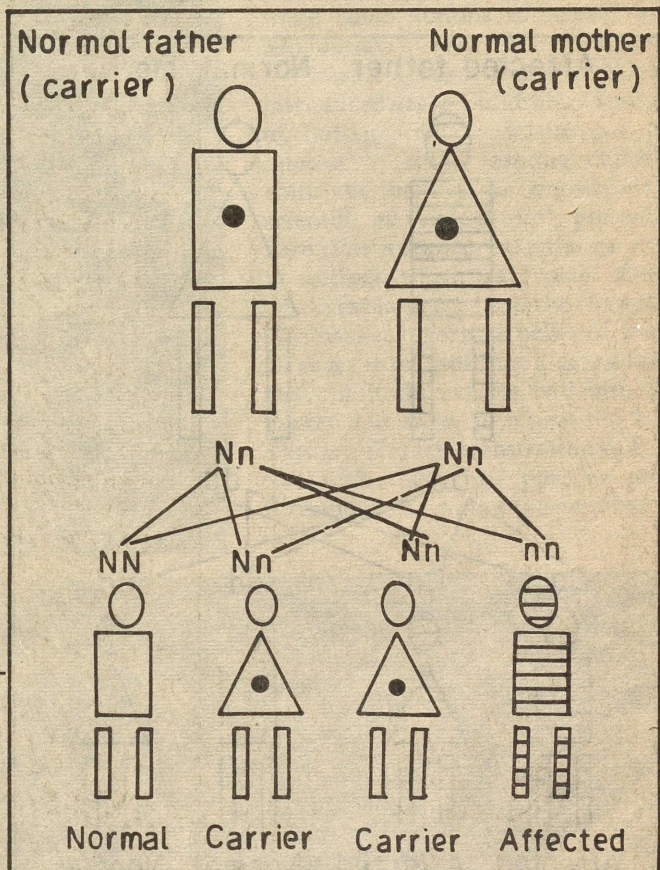


Fig. 4 (a). Autosomal recessive mode of inheritance

passes to almost half of the offsprings. Individuals of both sexes are equally affected and generally the affected individuals are present in each generation of the affected family (Fig. 4b).

X-linked retinitis pigmentosa is the least common type. In patients with this disorder patients, the 'defective' gene is located on the X-chromosome of the individual. The frequency of affected males is more than females in these families. Its transmission is from the normal-unaffected carrier females to affected males. All the sons of an affected male would be normal while all the daughters would be normal-unaffected carriers, and half of the sons of these carrier-daughters would be affected with retinitis pigmentosa (Fig. 4c).

Retinitis pigmentosa is also found to be associated with a number of

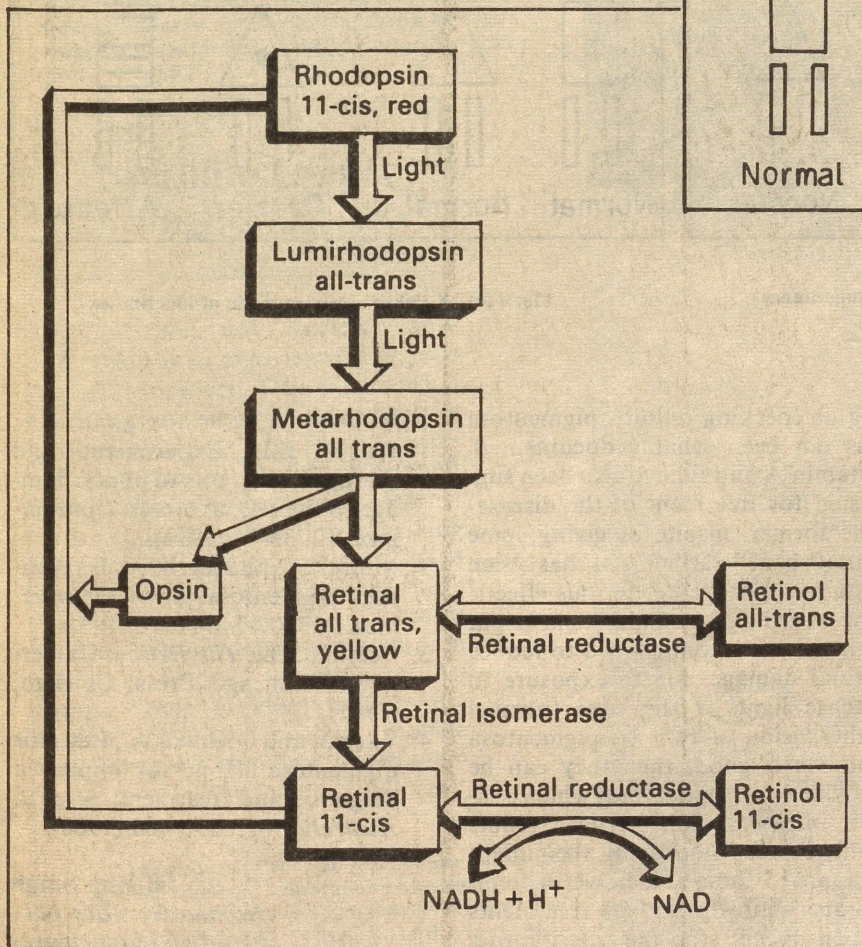


Fig. 3. Visual cycle of rhodopsin (adapted from *General & Comparative Physiology* by William S. Hoar, 3rd ed., 1984)

## MEDICAL NOTES

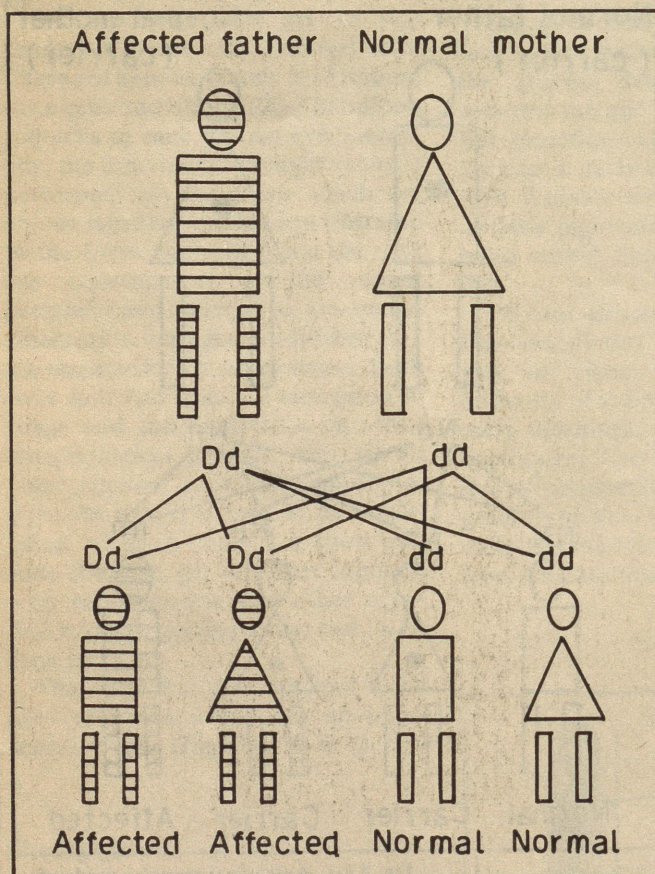


Fig. 4 (b). Autosomal dominant mode of inheritance

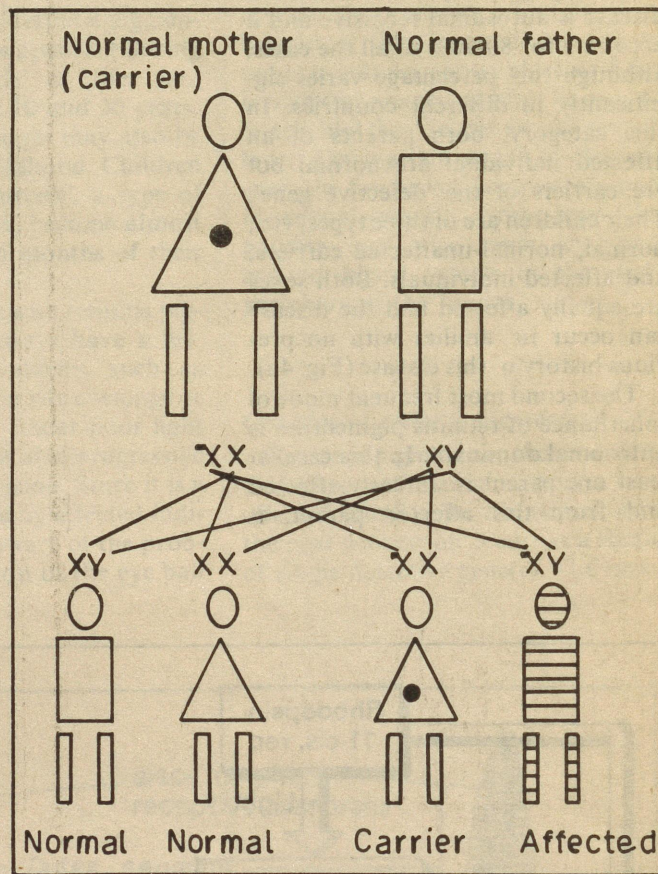


Fig. 4 (c). X-linked recessive mode of inheritance

other diseases and disorders like cataract, congenital hearing loss (Usher's syndrome), and chronic progressive external ophthalmoplegia (paralysis of one or more of the motor nerves of the eye).

### Treatment

Many drugs have been suggested for the treatment of retinitis pigmentosa. They include anticoagulants, xanthinol niacinate and other vasodilators (drugs which dilate blood vessels), injections of hyaluronidase and acid phosphatases. Transplantation of human placenta, practised for many years, still continues to be used by some. Surgical transplantation of strips of extraocular muscles for improving the choroidal blood flow has also been used. But the success of any of these treatments for improv-

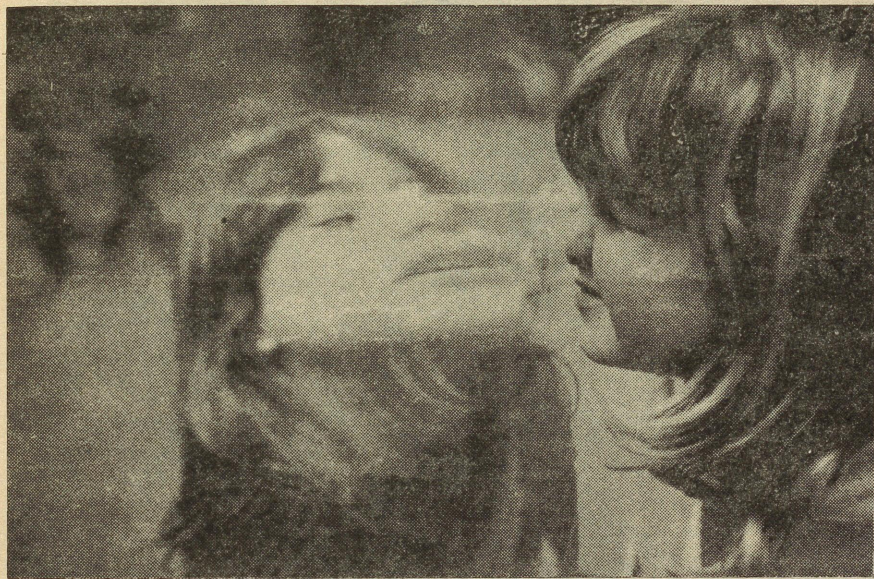
ing or checking retinitis pigmentosa has not been reliably documented. Vitamin A and E have also been suggested for treatment of the disease. The former, in spite of giving some initial beneficial effects, has been reported to have deleterious effects. The wearing of dark glasses in bright light is also recommended to reduce retinal damage due to exposure to intense light. If the cone (normal light) vision of retinitis pigmentosa patients is good, then they can be provided with optical aids which convert infra-red radiation into visible light, thereby improving their night vision. All these are, however, temporary short-duration treatments which do not stop the deteriorating vision. Retinitis pigmentosa, therefore, still continues to be incurable.

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## SCIENCE FOR THE YOUNG



California's Exploratorium science museum offers youngsters and adults of all ages an entertaining and educational experience with the wonders of science. More than 600 participatory exhibits include demonstrations in optical illusion, shown here, as a youngster peers through pinhole in magnified glass (photo: U.S.I.S.)

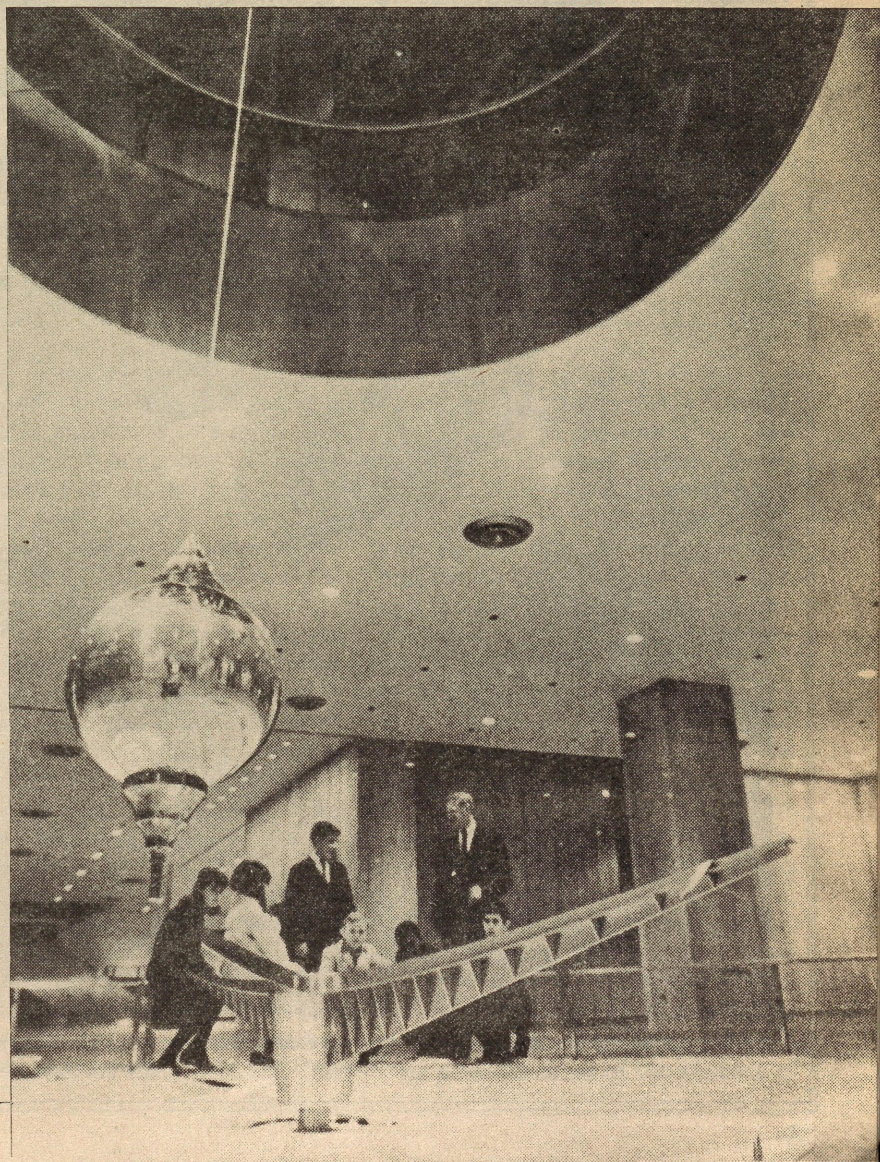
### Learning science through museums

**T**HE best way to learn anything is to experience it in your bones. Moreover, if the experience is thrilling and entertaining, it is all the more easy to learn that thing. Science is often considered dull or difficult but it can also be made easy to learn if it is properly packaged in a thrilling and entertaining experience. This is what the new exhibits that have recently been displayed in some of the better known science museums in the U.S.A. draw attention to. An *Appu Ghar* provides only bodily thrills but these exhibits provide mental thrills too. One leaves them

The Foucault Pendulum is a popular attraction in the Smithsonian Institution's Museum of History and Technology in Washington. As the 255-pound brass ball swings slowly back and forth over the dial on the floor, it demonstrates the earth's rotation on its axis. (Photo: U.S.I.S.)

with not only child-like joy but also some basic notions of science and technology.

"Science of Sports" is the exhibit introduced at the Children's Museum of Indianapolis. How the growing interest in sports among children could be utilised to popularise a scientific principle is nicely presented here. For instance, take the game of basketball which rats play. Every time a rat jumps up and throws a ball into basket it earns a pellet of food. Once a rat realises that it gets a food pellet if it throws the ball into the basket it is eager to repeat the feat. This is a clear demonstration of B.F. Skinner's theory of positive reinforcement. As a result, a number of





Using a scale model of the room-sized device, a guide at The Computer Museum explains the workings of the early commercial vacuum tube computer UNIVAC to a school group. (Photo: U.S.I.S.)

## SCIENCE FOR THE YOUNG

eager rats are waiting on a visitor to throw a ball at them! Besides, there are several hands-on exhibits which allow a visitor to test his or her peripheral vision, balance, reaction-time and muscle control. In the process he or she learns a lot about his or her own body anatomy, physiology, psychology and physics.

"Superheroes: A High-Tech Adventure" is another newly introduced exhibit at Portland. This exhibit is a huge complex which will move from one city to another in the coming years. The complex contains several tall buildings, each one dedicated to one super hero such as Superman, Batman, Spiderman, Wonder Woman, etc. Each building highlights the special feats of that super hero to visitors. For instance, in the Spiderman's exhibit there is a huge, elaborate web. Visitors are supposed to climb into the web and learn how spiders trap insects. Then there is a fibre-optic system available in Superman exhibit which throws light upon the super hero's X-ray vision. This fibre-optics system like the endoscope that surgeons use nowadays in hospitals allows a visitor to see inside the stomach of a person. Then there are exhibits which give a first hand idea of how forensic science detects a crime. A visitor is provided with fingerprints of the culprit, a gas chromatography equipment to analyse the chemical structure of tiny bits of materials found at the site of the crime, etc., to analyse the crime and identify the criminal like the superheroes of the comic strips do.

"Movie Special Effects" is the exhibit displayed at the Franklin Institute, Philadelphia. This exhibit takes advantage of the interest of visitors in some characters and events from the celluloid world which have left an imprint on their mind. Who-soever has seen the movie "Jaws" remembers that villainous shark which kills people on beaches; the huge gorilla of the "King Kong" movie which creates terror in a city is yet another memorable character; and so on. Besides, film stunts like

crashes and explosions also leave a lasting impression on the mind of the viewer. In reality, these are all illusions created in our brain. How they are created in our brain is the theme of this exhibit. By controlling the speed of motion of the images, a visitor is able to ascertain how he or she has been tricked into believing certain things that looked real on the wide screen. The San Francisco's Exploratorium has put up a similar "Perception" which gives an idea of how well or poorly the brain perceives the world. A visitor begins to doubt his or her own senses after touring the exhibit.

The Tampa Museum of Science and Industry's "Dinosaur Alive!" is yet another exhibit which is drawing huge crowds. Though mankind is drawing close to the 21st century, the interest of the public in the creatures dead millions of years ago has not waned. Life-sized, rubber-skinned replicas of those giant creatures

which move various parts of their body, make noise, chew cud or kill each other are on display in this museum. If a visitor desires he or she can even control the movement of a dinosaur by simply handling a joystick. Then there are movies, puppet-shows and all kinds of activities revolving around these creatures that give visitors a glimpse of the kind of life they led, the food they ate and the circumstances in which they disappeared from the face of earth. From dinosaurs to computers has been a long trek for mankind. The Computer Museum at Boston gives an idea of this trek, among other things. It provides a visitor first-hand knowledge of computer graphics and image processing and also a peep at the intricate circuitry of a microchip. Besides, friendly computers acquaint visitors with their own working and how they could be put to novel uses.

Dillip M. Salwi

### Missing links in the periodic table

**T**HE chemical elements in the periodic table are arranged in a systematic manner with similar elements placed in one group or family, the members of which show similar chemical and physical properties. The periodic table in its modern form is a contribution of several workers including the Russian chemist V.I. Mendeleef. When Mendeleef framed the periodic table, all the ninety-two elements were not known, the table had only 63 elements. There were many vacant places in the periodic table, which were gradually filled up as new elements were discovered long after Mendeleef. Till the middle of the present century four places remained vacant in the periodic table inspite of hectic search for the unknown elements by chemists all over the world.

Any element is denoted by two numbers. One is the atomic number and the other its mass number. The

atomic number, which decides the position of an element in the periodic table, also corresponds to the number of protons present in its nucleus. On this basis, hydrogen is given the atomic number 1, helium 2, and so on till uranium which is number 92. Out of these 92 elements, only 88 are found on earth. So the positions of the remaining four elements with atomic numbers 43, 61, 85, and 87 remained vacant for a long time. During 1920-30, vigorous efforts were made to search for the missing elements to make the periodic table complete. Many workers reported the discovery of some dubious elements and even went so far as to give them names like masurium, illinium, florentium, alabamine, virginium, and moldavium. But these discoveries were ultimately proved to be bogus as the new elements could not be confirmed by other workers. One possible cause of the absence of

# SCIENCE FOR THE YOUNG

Period	Group																VIIA	0			
	IA	IIA		IIIB	IVB	VB	VIB	VII B	VIII			IB	IIB	III A	IVA	VA			VIA	I	2
1	1 H															5 B	6 C	7 N	8 O	9 F	10 Ne
2	3 Li	4 Be														13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
3	11 Na	12 Mg		21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr		
4	19 K	20 Ca		39 Y	40 Zr	41 Nb	42 Mo	43 Technetium	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe		
5	37 Rb	38 Sr		72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 Astatine	86 Rn			
6	55 Cs	56 Ba		88 Ra	89 Ac	104 Rf	105 Ha														
7	87 Francium	88 Ra		89 Ac	104 Rf	105 Ha															

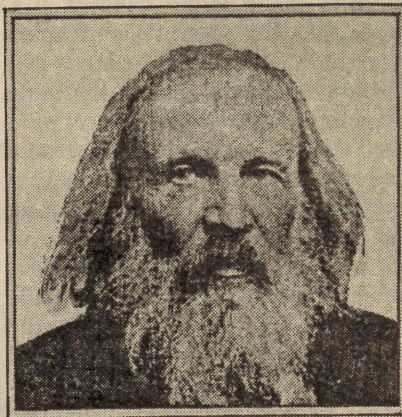
6*	58 Ce	59 Pr	60 Nd	61 Promethium	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
7*	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

The Periodic Table and the missing elements

the missing elements on earth could be that they are radioactive and have comparatively shorter half-lives. They may have been on earth long ago, but might have since decayed and disappeared. As these elements do not occur on present-day earth, the world had to wait to see them till they could be produced artificially. These four elements popularly known as the *missing links* of the periodic table have since been prepared artificially.

Out of the four missing link elements, the first to be synthesized was technetium with symbol Tc and atomic number 43. It fills the gap between molybdenum (42) and ruthenium (44) in the periodic table. The new element was first identified by C. Perrier and E. Segre of Italy in 1937. A sample of molybdenum, irradiated by deuterons in the cyclotron of the University of California, U.S.A. was sent to them for identification. They analysed the sample and isolated a fraction, the radioactive and other properties of which were similar to the properties predicted for the ele-

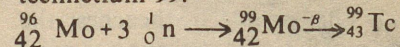
ment of atomic number 43. Ten years later Segre named this new element technetium derived from the Greek word *technikos*, meaning the element of technical or artificial origin. Technetium is a radioactive element with mass number 99 and has a half-life of only six hours. It can be prepared easily in atomic reactors. A salt of technetium, ammonium pertechnetate, finds wide use in medical diagnosis for the location of brain



V. I. Mendeleev

tumors. This is done by injecting pertechnetate intravenously followed by a scan of the brain with help of a gamma camera, either in front or back and side. The scan image shows the exact location of the tumor. Various organic compounds containing technetium have been prepared, injected and scanned in order to get the picture of diseased organs like liver, kidney, thyroid, etc. A new branch called nuclear medicine has emerged, centred around this particular element.

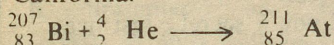
Technetium is produced as a by-product of atomic reactors as it constitutes 6.2 per cent of the fission products. When one gram of  $^{235}\text{U}$  is fissioned, it produces 26mg of technetium. The element can also be prepared by irradiating molybdenum with neutrons to form  $^{99}\text{Mo}$  which decays by  $\beta$ -decay to give technetium-99.



The second missing link element to be synthesized was astatine with atomic no 85 and symbol At. It is

## SCIENCE FOR THE YOUNG

grouped under halogens and hence has a name ending with 'ine'. It was prepared in 1940 by irradiating bismuth with high-speed alpha particles by D.R. Corson, K.R. Mackenzie and E. Segre at the University of California.



They named it astatine after the Greek word Astatos meaning unstable. The particular isotope of astatine which was synthesized first is  ${}_{85}^{211}\text{At}$ , which is an alpha emitter. It exhibits the phenomenon known as 'branched decay' as some atoms breakdown in one way while others decay in a different way, though both yield alpha particles. Astatine is more electropositive than iodine, hence it can be separated from solution by electrolysis. The longest lived isotope of astatine ( ${}^{210}\text{At}$ ) has a half-life of 8.3 hours.

Promethium, with atomic number 61 and symbol Pm was the third missing link element to be synthesized. It belongs to the family of rare-earth elements. As these elements normally occur together, rare-earth ores collected from all possible sources were analysed for this element, but without any success. Although a number of claims to its discovery were made, the question of its existence in nature could not be settled for a long time. It was prepared synthetically by different groups of investigators. Some groups irradiated neighbouring rare-earth elements and produced some new sources of radioactivity. Development of methods for separation of rare-earth elements by synthetic ion-exchange resins helped ultimately to isolate element 61 in a pure form. The element could also be prepared in the fission of  ${}^{235}\text{U}$ . The first positive identification of the element 61 came in 1945 from the work of J.A. Marinsky and L.E. Glendenin at the Clinton National Laboratory, Oakridge, U.S.A. They suggested that the element should be named promethium after the Greek God Prometheus to draw a parallel between mankind's newly acquired nuclear power and fire which Prometheus stole from heaven for men. The longest lived

isotope of promethium is  ${}^{145}\text{Pm}$  with a half life of nearly 30 years. At Oakridge National Laboratory, G.W. Parker and P.W. Lantz obtained promethium from a fission product mixture. B.H. Ketelle and G.E. Boyd isolated this element from neutron irradiated neodymium.

The fourth and final missing link element to be discovered was Francium, symbol Fr, atomic no 87. The element belongs to the family of alkali metals and is placed next to caesium. There is no stable isotope of element 87 and longest lived isotope has a half life of only 21 minutes. So it

could not have been detected by any conventional chemical means. It was not until 1939 that Mille M. Perey of the Curie Institute, Paris, France succeeded in isolating the element from the alpha decay products of  ${}^{227}\text{Ac}$  by radiochemical separation. Perey named this new element Francium in honour of her native country. Francium is made in appreciable quantity by irradiating thorium-232 with neutrons to form  ${}^{233}\text{Th}$ , which then decays to Francium.

**Gokulananda Mahapatra**  
*Dolmundai, Cuttack-753009*

### A quiz on vitamins

1. Which vitamin is synthesised by the human body?
  - (a) Vitamin C
  - (b) Vitamin B<sub>12</sub>
  - (c) Nicotinic acid
  - (d) Folic acid
2. A vitamin containing a vitamin is:
  - (a) Retinoic acid
  - (b) Pantothenic acid
  - (c) Folic acid
  - (d) Ascorbic acid
3. The term 'vitamin' was coined by:
  - (a) Elmer Verner McCollum
  - (b) Casimir Funk
  - (c) Albert Szent-Gyorgyi
  - (d) Dorothy Crowfoot Hodgkin
4. Which is not a vitamin?
  - (a) Pyridoxamine
  - (b) Menaquinone-6
  - (c) L-dehydroascorbate
  - (d) D-ascorbate
5. Flour is often enriched with:
  - (a) Biotin
  - (b) Vitamin A
  - (c) Vitamin B<sub>1</sub>
  - (d) Vitamin E
6. Scurvy is to vitamin C as fatty liver is to:
  - (a) Vitamin K
  - (b) Pantothenic acid
  - (c) Riboflavin
  - (d) Choline
7. Deficiency of this vitamin produces bleeding tendencies:
  - (a) Vitamin B<sub>1</sub>
  - (b) Vitamin B<sub>2</sub>
  - (c) Vitamin C
  - (d) Vitamin K
8. If maize is the staple diet, the deficiency is likely to be of:
  - (a) Cholecalciferol
  - (b) Nicotinic acid
  - (c) Pyridoxine
  - (d) Thiamin
9. What needs to be stored in dark bottles?
  - (a) Biotin
  - (b) Nicotinic acid
  - (c) Riboflavin
10. Intestinal microflora is a reliable source for:
  - (a) Vitamin B<sub>6</sub>
  - (b) Vitamin K<sub>2</sub>
  - (c) Biotin
11. Macrocytic anaemia can result from the deficiency of:
  - (a) Folic acid
  - (b) Vitamin B<sub>2</sub>
  - (c) Inositol
  - (d) Vitamin B<sub>12</sub>
12. Vegetable oils are often fortified with:
  - (a) Vitamin C
  - (b) Vitamin D
  - (c) Vitamin E

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*(Solutions on page 329)*

Limericks in science



There was a pretty girl from Italy  
Who had many suitors silly and not  
so-silly  
Since she had a choice wide  
Whom to marry she could not decide  
To find the most suitable  
she called their assembly

Boys came from all over Europe,  
Africa and Asia  
And brought beautiful flowers,  
roses, jasmines and dahlia  
But one fella told the host  
"I love you the most,  
That's why I brought you,  
the flower of Rafflesia!"

(The rafflesia flower is 90cm  
across, weighs up to 10 kg)

\* \* \* \* \*

There was a very intelligent chemistry  
guide  
Who for bleaching hair a new  
method tried  
But he lost bunches of hair  
Till his scalp was bare  
Because he did it with conc.  
sodium hydroxide

\* \* \* \* \*

A gynaecologist told his friend,  
a chemist serious  
Your classification of elements  
sometimes makes me delirious  
Of groups you may talk  
But I get a shock  
When you start talking of  
Mendeleev's 'periods'

\* \* \* \* \*

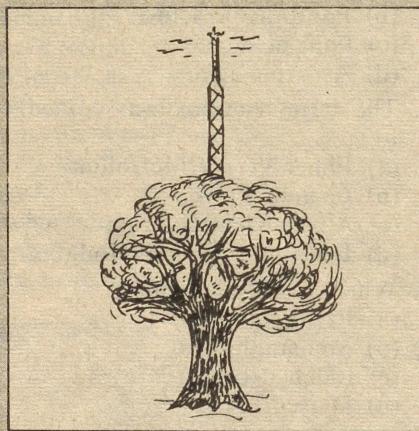
A brilliant botanist once crossed  
carrot and tomato  
To make whole plant edible including  
the root oh!  
But he cursed his luck  
When he had to pluck  
A plant with leaves of Carrot and  
roots of Tomato

\* \* \* \* \*

There was a woman from an  
African nation  
Who gave birth to twins and to  
everyone's consternation  
One was black, the other white  
A truly awkward sight  
Sure enough, it was a case of  
Superfecundation.

(Superfecundation is the pheno-  
menon of fertilization of two ova of  
the same cycle by two different acts of  
coitus by two different men)

\* \* \* \* \*



There was a young scientist from Goa  
Who wanted his brilliance to show ya  
To increase the transmission range  
He proposed a technology change  
And asked the transmitter to be put  
over a giant sequoia.

(Word enthusiasts may observe with  
interest that the word 'Sequoia'  
contains all the 5 vowels—one of the  
very few to show this property)

\* \* \* \* \*

To an electron said a positron  
with a jeer  
I will tell you a secret, just hear  
I am no different  
From you, my friend  
But I am running back in time,  
my dear

\* \* \* \* \*



There was a young individual  
from Rome  
Who went from one to the other  
nursing home  
But the doctors couldn't scan  
If he was a man or woman  
Because he suffered from  
Klinefelter's syndrome

\* \* \* \* \*

There was a man from the city  
of Cheiro  
Who considered himself to be a  
mathematical hero  
He was really very confident  
Of his mind's mathematical bent  
Till some one asked him to divide  
one by zero  
He employed all techniques in his kitty  
But couldn't break this enigma so  
witty  
When he couldn't find a way  
To keep embarrassment at bay  
He took a plunge from a cliff to  
infinity

Anil Aggarwal  
S-299, Greater Kailash  
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Further properties of triangular numbers

THE numbers 1, 3, 6, 10, ... can be represented as triangular patterns of dots and so are called triangular numbers. These numbers show a variety of interesting properties, some of which have already been discussed (S.R., September, 1987, p. 495). Some additional characteristics of these numbers will be explored here along with analytical proofs which make the study of these numbers interesting and enjoyable.

1. A triangular number  $T_n$  can be represented as the sum of a square number  $S_n$  and a cubic number  $C_n$  through the relation,  
 $T_n = 1/2n (S_n + C_n)$

This relation can be easily established by writing  $S_n = n^2$  and  $C_n = n^3$ .

2. Any triangular number greater than 3 can be represented as the sum of a square number and two equal triangular numbers. For analytical proof, the triangular number  $T_n [= n(n+1)/2]$  for  $n$  even ( $n=2m$ ) and  $n$  odd ( $n=2m+1$ ), respectively, is written in the form

$$\begin{aligned} T_{2m} &= m(2m+1) \\ &= m^2 + m(m+1) \\ &= m^2 + 2[m(m+1)/2] \\ &= m^2 + 2T_m \end{aligned}$$

$$\begin{aligned} T_{2m+1} &= (2m+1)(m+1) \\ &= (m+1)^2 + m(m+1) \\ &= (m+1)^2 + 2T_m \end{aligned}$$

In terms of  $n$ , these relations may be written as

$$\begin{aligned} T_n &= (n/2)^2 + 2T_{n/2} \dots \text{for } n \text{ even} \\ T_n &= [(n+1)/2]^2 + 2T_{(n-1)/2} \\ &\dots \text{for } n \text{ odd} \end{aligned}$$

Thus,

$$\begin{aligned} T_4 &= 4 + 2T_2 & ; 10 &= 4 + 3 + 3 \\ T_7 &= 16 + 2T_3 & ; 28 &= 16 + 6 + 6 \\ T_8 &= 16 + 2T_4 & ; 36 &= 16 + 10 + 10 \\ T_{11} &= 36 + 2T_5 & ; 66 &= 36 + 15 + 15 \end{aligned}$$

3. An interesting property of triangular numbers is that the square of the  $n^{\text{th}}$  triangular number is equal

to the sum of the sequence of  $n$  cubic numbers starting from unity. This follows readily by invoking the elementary knowledge of algebra. The sum of the cubes of the first  $n$  natural numbers is  $[n(n+1)/2]^2$ . But  $T_n = n(n+1)/2$ . So,  
 $1^3 + 2^3 + 3^3 + \dots + n^3 = T_n^2$

4. Any odd square can be represented as one more than eight times a triangular number. Mathematically,  $S_{2n+1} = 8T_{n+1}$

The above relation showing connection between the triangular number  $T_n$  and the odd square  $S_{2n+1}$  was first of all found by the ancient Greek mathematician Diophantus of Alexandria who lived in the third century B.C. This relation is, therefore, named Diophantus' formula. This relation can be easily established.

Writing  $T_n = n(n+1)/2$

$$\begin{aligned} \text{Thus } 8T_{n+1} &= 8[n(n+1)/2] + 1 \\ &= 4n(n+1) + 1 \\ &= (2n+1)^2 = S_{2n+1} \end{aligned}$$

5. Multiplying a triangular number by 9 and adding unity to the result again generates a triangular number. This property is capable of easy proof.

$$\begin{aligned} 9T_{n+1} + 1 &= 9[n(n+1)/2] + 1 \\ &= \frac{1}{2}(9n^2 + 9n + 2) \\ &= \frac{1}{2}(3n+1)(3n+2) \\ &= T_{3n+1} \end{aligned}$$

Thus,

$$\begin{aligned} 9T_1 + 1 &= T_4 \\ 9T_2 + 1 &= T_7 \\ 9T_3 + 1 &= T_{10} \\ 9T_4 + 1 &= T_{13} \end{aligned}$$

.....  
 .....

6. Every perfect number is known to be a triangular number, though the converse is not true. This can be easily shown by writing the perfect number in the form

$P_q = 2^{q-1} (2^q - 1)$   
 where  $q$  and  $2^q - 1$  are both primes.

Letting  $2^q - 1 = n$  the above relation reduces to

$$P_q = \frac{(n+1)n}{2} = T_n$$

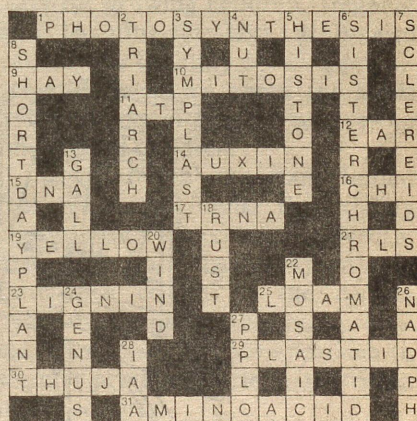
The perfect numbers obtained for  $q=2, 3, 5, 7, \dots$  are respectively  $P_q = 6, 28, 496, 8128, \dots$ . These numbers are all triangular corresponding to  $n=3, 7, 31, 127, \dots$ . So, the perfect numbers conform to the sequence of triangular numbers  $T_3, T_7, T_{31}, T_{127}, \dots$

7. A square number can be represented by the sum of two consecutive triangular numbers. A rectangular number  $R = n(n+1)$  is likewise expressible as the sum of two equal triangular numbers. Other numbers can be represented by the sum of three triangular numbers, viz.,

$$\begin{aligned} 85 &= 78 + 6 + 1 = T_{12} + T_3 + T_1 \\ 107 &= 105 + 1 + 1 = T_{14} + T_1 + T_1 \\ 1750 &= 1711 + 36 + 3 = T_{58} + T_8 + T_2 \end{aligned}$$

It may be interesting to note that there are no positive integers which require more than three triangular numbers for their representation.

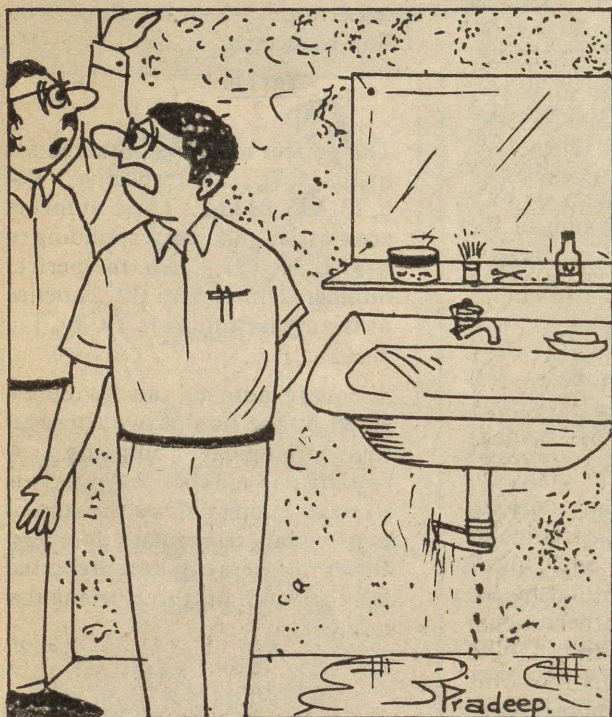
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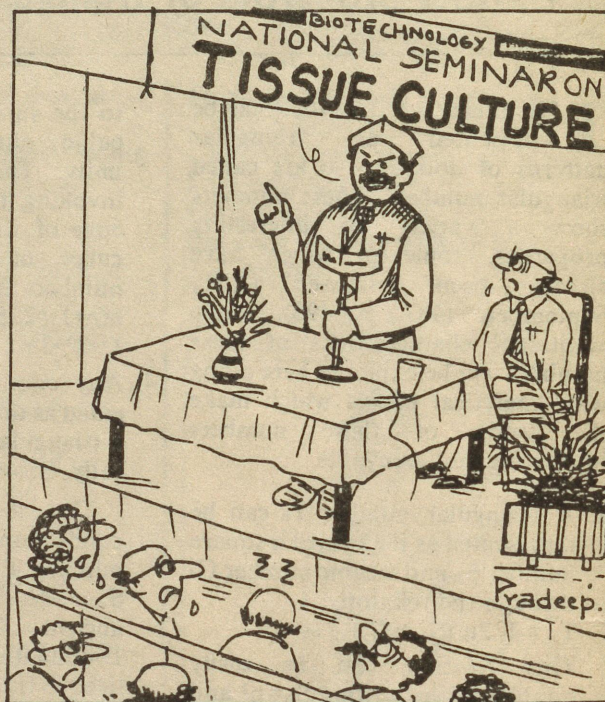
Solution to crossword puzzle, S.R. June 1989, p. 205

## CARTOONS

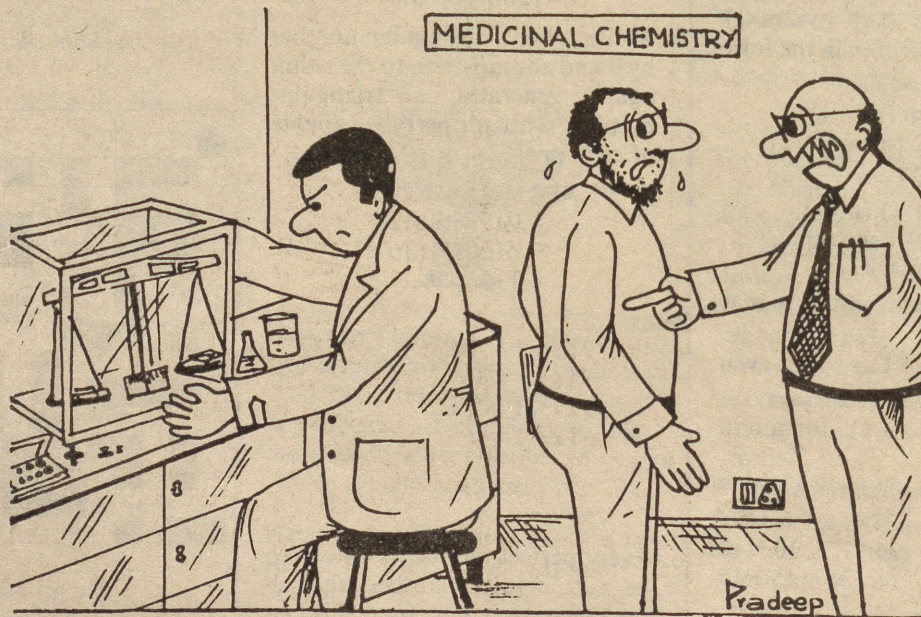
By Pradeep K. Srivastava



"I am fed up with this fungus growth. I requested the authorities many times for a 'whitewash'. But, see! Instead of ordering for the same, they sent a team of 'mycologists' to do research on it".



"More and more such conferences should be organised to educate people about our great ancient culture and heritage".



"And still you claim that he is a genius in research? See! I just asked him to balance a chemical equation".

## Pulses for protein

**P**ULSES are a rich source of protein and serve as a low-cost food to meet the needs of a large section of the people of India, particularly the poor. In India, people are mostly vegetarian and do not use animal proteins because of religious belief. Today, even non-vegetarians are shifting to pulses due to high cost of meat and fish. Unfortunately, the country has not been able to achieve self-sufficiency in pulses. During the last three decades, pulse production and the cultivable area have remained more or less stagnant, ranging between 10-12 million tonnes and about 23.5 million hectares respectively. Consequently, we had to depend on imports to meet a part of its shortage. The National Commission on Agriculture has estimated that we should plan to produce 24.7 million tonnes of pulses by the end of this century to meet the dietary protein needs of the population expected to be 935 million by 2000 AD.

The per capita availability of pulses has gradually declined with the increasing population, production remaining stagnant. It has declined from 70 gm in 1956 to 38.9 gm in 1985 in the main pulses producing states (Madhya Pradesh, Rajasthan and U.P.) against 80 gm recommended by the WHO/FAO. An earlier dietary survey on per capita consumption of pulses in different states showed that in Jammu & Kashmir and Tamil Nadu it was as low as 8 gm and 16 gm per day, respectively, and in U.P. and M.P., it was as high as 55 gm/day (Table 1).

Pulses in general contain 20-30 per cent proteins, about 60 per cent carbohydrates and are a good source of thiamine and nicotinic acid. They provide calcium and iron as well. Pulse carbohydrates contribute as many calories per unit weight as cereals. On an average, 100 gm of pulses provide 345 Kcal., 24 gm protein, 140 mg calcium, 8.0 mg iron, 300 mg phosphorus, 0.5 mg thiamine, 0.3 mg riboflavin and 2.0 mg nicotinic

acid.

In India, pulses are used in various forms. They are commonly used as 'dal' alongwith 'chapaties' and cooked rice. Whole seeds take longer time in cooking while dehusked and decorticated ones take less time, and are relatively better digestible.

It is a common practice to use pulse flour such as that of bengalgram, greengram and blackgram in the form of 'besan' for mixing with cereal flour in different proportions for various preparations. Parched bengalgram, peas and roasted greengram dal are also commonly consumed as food.

Sprouting and fermentation processes markedly improve availability of nutrients in pulses. Sprouting not only improves nutritive value of a pulse but its digestibility also. During sprouting, starch is broken down to polypeptides, peptides and amino acids. Some of the bound iron is converted to a more readily available form. Phosphorus is liberated from phytate. These changes are brought about by enzymes which become active during germination. The amount of certain vitamins like vitamin C, folic acid, etc., also increases during germination. Fermentation also improves food value of these seeds. Fermented food is an

important component of the diet in several parts of the world. In India, 'Idli', 'Dosa', 'Dhokla' and 'Uttapam' are most common preparations from pulses. Fermentation enhances thiamine, riboflavin and nicotinic acid content and inactivates trypsin inhibitor which interferes with protein digestion.

Pulses are sometimes adulterated with undesired substances such as sand, marble chips, stones, etc. Sand or grit, if present in dal, will have an adverse abrasive effect on the soft lining of the digestive tract. Sometimes, pulses like blackgram are polished with talc (hydrated magnesium silicate). It has been observed that there is widespread adulteration of bengalgram and redgram with khersari dal which causes human lathyrism—a crippling disease.

Pulse proteins are inferior due to deficiency of sulphur-containing amino acids. They are however rich in lysine—an essential amino acid, in which cereals are relatively deficient. Consequently, proteins in a mixed diet of cereals and pulses are nutritionally better than when either eaten alone. A quantity of pulses as small as one-tenth that of cereals helps make good deficiency of lysine.

The average Indian diet is not only insufficient in calories, it is also unbalanced in its composition. A large section of people suffer from protein-calorie malnutrition particularly the growing children, pregnant and lactating mothers. It is also caused due to faulty cooking practices and ignorance about the kinds and amounts of food to be given to infants and children.

Pulses are an important Indian diet. Therefore, under the existing conditions of our economic development, their use in the diet in combination with cereals in the correct proportion is perhaps the only practical, cheap and feasible approach to counter protein-calorie malnutrition in the country.

Y.P. Gupta

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Indian Agricultural Res.  
Institute, New Delhi-110012

Table 1. Consumption pattern of pulses in India

State	Daily per capita consumption (gm)
Madhya Pradesh	55
Uttar Pradesh	55
Gujarat	43
Rajasthan	43
Bihar	42
Punjab	35
Maharashtra	33
West Bengal	30
Andhra Pradesh	29
Karnataka	26
Kerala	24
Tamil Nadu	16
Jammu & Kashmir	8
All-India	34

## New synergistic fire retardants for natural rubber

**T**HE Regional Research Laboratory (RRL), Trivandrum, has developed a new fire retardant natural rubber composition using a synergistic combination of antimony oxide and ANORIN 44, a phosphorus and halogen containing prepolymer from CNSL. These compositions (patent filed) have been found to be self-extinguishing in vertical burning tests, and have high limiting oxygen index (LOI, a measure of fire retardancy). The LOI value of 42 obtained is the best ever reported on fire retardant natural rubber. The flammability characteristics and mechanical properties of typical fire retardant natural rubber composition have been found to be: time for self-extinction, 0.5 to 1s; weight loss on burning, 1.085%; LOI, 42; hardness, 58 Shore A; tensile strength, 224.06 N/cm<sup>2</sup> and elongation at break, 400%. The corresponding values for an untreated natural

rubber sample are LOI, 15; time for self-extinction, 145s; weight loss, 35.6%; hardness, 39 Shore A; tensile strength, 139 N/cm<sup>2</sup> and percentage elongation at break, 160. Besides, these formulations are also found to be easily processable on the roll mill and amenable for compression moulding into desired shapes improving their commercial appeal.

ANORIN 44 is prepared by ANORIN 38—a phosphorus containing prepolymer developed from CNSL, the technology of which is being jointly released by RRL-Trivandrum and the Vikram Sarabhai Space Centre, Trivandrum. Being based on CNSL which is obtained from the cashew tree (*Anacardium occidentale* L.), ANORIN 38 and ANORIN 44 are very cost effective compared to other phosphorus and bromine-based fire retardants available in the international market. The

presence of both hydrophobic hydrocarbon side chain and the hydrophilic polar groups in the same molecule makes these resins compatible with a wide range of plastics and elastomers.

ANORIN 38 has been already found to give adequate fire retardancy to polyurethane polymers and thermo plastics. Since these resins are high viscous liquids, they do not bloom. The presence of reactive sites gives them the choice of use as reactive fire retardants whereby they can be permanently coupled to the main polymer chain either by direct reactions or by inter penetration through insite cross-linking reactions. It was also found that the problem of generation of smoke due to the presence of the halogen can be easily overcome by incorporating smoke suppressant such as boric acid which itself is a fire-retardant.

## Roof surface evaporation using gunny bags

**T**HE Central Building Research Institute (CBRI), Roorkee, has designed a process of cooling by gunny bags. The process requires a small quantity of water 6 to 9 litres per sq.m. roof surface area per day under hot-wet to hot-dry conditions. The water consumption is more or less the same as required for desert coolers. Water can be sprayed by manual or automatic devices, specially designed for the process. During the course of alternate wetting and drying the spraying system has to work for a maximum duration of 50 minutes in 24 h. It sprays intermittently for a period varying one to five minutes at a time, depending on the intensity of solar-radiation and wind-velocity incident on roof terraces at

different times. Cooling is done in an economical and effective way based on the principle of evaporation which takes place at all temperatures. The latent heat of water has been fully exploited for maximum benefit of cooling.

The severity in the indoor discomfort conditions either due to harsh climate or bad thermal design/low cost aspects can be compensated automatically by this process in providing natural thermal comfort indoors. The process attempts to bring the indoor dry bulb temperatures of building very near to the outdoor wet bulb temperatures. In the case of airconditioned buildings it could reduce the energy consumption up to 30% and capital savings up to

60% under the worst exposure conditions. This simple process has the potential of boosting lowcost housing schemes in hot regions of earth.

The running cost for an average size of room during a summer season comes out to Rs 100 utilizing hand operative device of spraying water and empty cement bags.

Presently, the Institute is working on design and implementation of this cooling process on the newly constructed buildings of Solar Energy Centre, Department of Non-conventional Energy Sources, Ministry of Energy, New Delhi. The cooling process can also be extended to cool apartments.

□

## BOOK REVIEWS

**HUGGING THE TREES** by Thomas Weber, *Viking* (Available from: *Penguin Overseas Ltd.*, 706, Eros Apt., Nehru Place, New Delhi-110017), Rs. 125 (Hardbound)

**H**UG the tree before the contractor puts his axe to it! This slogan was given to the villagers of the Garhwal Himalayas to save their trees from the greed of contractors in 1973. Today, the slogan has given birth to the Chipko movement for the conservation of forests which is fast catching up all over the world. In fact, its two main proponents, Sunderlal Bahuguna and Chandi Prasad Bhat, have become heroes in the forest conservation movement all over the world today. But, hardly few people know how this movement started, where it started and why it started. The subject is of considerable interest to the world but no Indian journalist braced himself or herself up to the task to produce a book on it, which would give proper background of the movement, its present status and if it could at all be the answer to save forests. It needed an Australian journalist with interest in Gandhian thoughts to come all the way to India and write a book on the movement on the basis of interviews, press clippings, and personal survey of the Garhwal Himalayas.

Quite surprisingly, the chipko movement did not start with the ideal purpose of saving trees. It has its roots in the social and economic conditions of villagers living in the Garhwal Himalayas. The villagers have come to realise that if they do not save trees, it will also be their own end. The author has however traced the roots of this movement to Mahatma Gandhi and some of his European followers who had till recently been living in this region. The book is a comprehensive and well documented guide to the movement and is likely to capture the world market at the cost of trees, of course.

**Dilip M. Salwi**

**MEDICINAL PLANTS AND THEIR USES** by Hans Fluck, Rita Jaspersen-Schib (Translated into English by J.M. Rowson), *W. Foulsham & Co. Ltd.*, (Available from: *Rupa & Co.*, 3831, Pataudi House Rd., Daryaganj, N. Delhi-110002), Pp. 187, £6.99, ISBN 0-572-00996-8

**H**ERBAL medicine has evolved in different ways in different parts of the world. Though all regions do not have well documented *Materia Medica* supported by a sound theoretical understanding, the use of plants for therapeutic purposes is well-known to all and is being handed over from generation to generation. The recent growth of interest in the use of medicinal plants and the search for newer and safer drugs from ethnic medicine has stimulated the publication of a number of books and research reports on these plants. There is a revival of herbals and herbalists.

The book under review is an English translation of a German book "Unsere Heilpflanzen" (4th edition, 1971) and its French translation "Herbes Medicinales" (2nd French edition, 1973) with some adaptations for use in Britain. Professor Fluck's herbal, based on scientific considerations, includes a brief monographic description of 152 principal plants selected from about 450 plants of Swiss flora that are used as remedies. Though the book deals with only Swiss plants, the majority of the plants are international. Three plants used in British herbal medicine, *Daphne laureola* L., *Taraxacum officinale* Webber, and *Verbascum thapus* L., have been added to corresponding monographs in this English translation.

In the main text of the book, the plants are arranged familywise under their common English names and under each plant are given the description of the plant (supported by beautiful coloured illustrations), parts used, habitat and collection, chemical constituents and actions

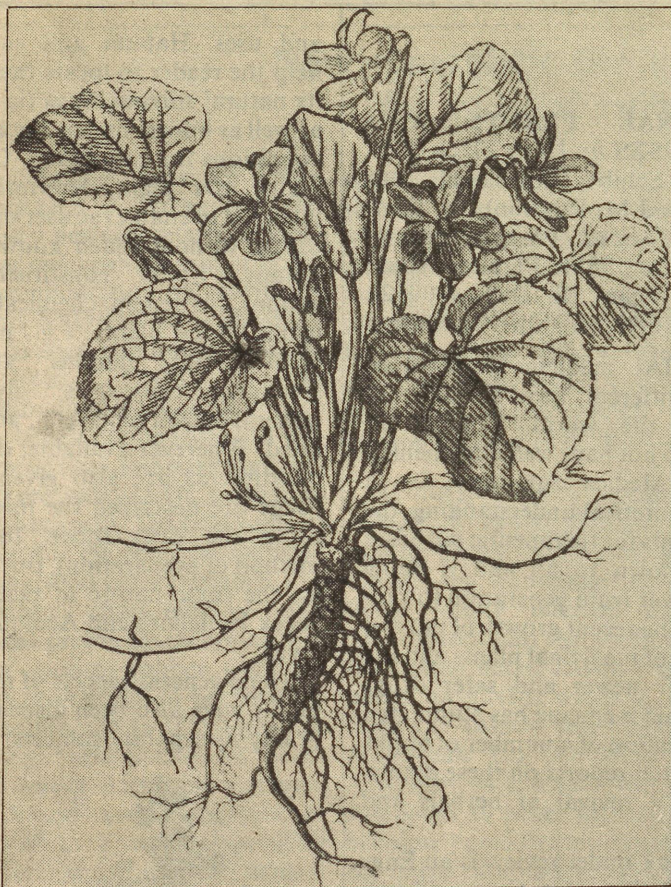
and uses. Habitat and cultivation help the reader to locate the plant in its natural surroundings (in Europe) as well as inform him or her about the conditions for cultivation. Coloured plates and plant descriptions are intended to enable the user to identify plants without much knowledge of botany. Under constituents and actions, the general chemical constituents of the plants, e.g., mucilage, volatile oils, tannins, alkaloids, saponins, coumarins, glycosides, mineral constituents, etc., are mentioned. Wherever available, the active constituents are also given. Under usage are described the methods of using the drug (dose, form and method of preparation). Information on the toxic nature of plants (e.g., Black Hellebore and Aconite) is also given.

Some general aspects of medicinal plants have also been discussed very briefly as separate subjects, e.g., the



Worm Wood

## BOOK REVIEWS



Violet

use of medicinal plants; some important groups of active plant constituents their mode of action; usage and methods of preparing medicinal plants (explaining methods of preparation of powders, teas, infusions and decoctions., etc.). Cultivation and collection of medicinal plants; popular names of medicinal plants; and calender for collection of medicinal plants.

Details of methods given for preparing Teas from Indigenous Plants, list of Common Important Ailments and plants used for their treatment greatly enhance the utility of the book. Index of common English and botanical names of plants and a glossary of terms have also been given at the end of the book.

The use of domestic measures of teaspoonful, tablespoonful, handful and knife-pointful used in the book along with the metric and imperial system give the folkloric appeal to

this herbal. The book, very nicely produced, is virtually free of typographical mistakes. This sound introduction to the medicinal uses of Swiss herbs will be of interest to any one having fascination for medicinal plants.

Gian Singh

**STATISTICAL MECHANICS** by B.K. Agarwal and Melvin Eisner, Wiley Eastern Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi-110002, Pp. 270, price not mentioned.

**S** TATISTICAL mechanics relates the macroscopic properties of a system to the microscopic properties which describe the constituent particles of the system. The most important aspect of this branch of physics is its correlation with thermodynamics

which also describes macroscopic systems. But, unlike statistical mechanics, thermodynamics does not take into consideration the existence of the constituent particles of the system.

The book under review deals with the basic concepts and techniques of statistical mechanics and is meant for advanced undergraduates in physics or chemistry or graduates in engineering classes. The text is divided into twelve chapters. The introductory chapter focuses on the elements of classical statistical mechanics based on the method of ensembles. The quantum picture is outlined in Chapter 2. The correlation between statistical mechanics and thermodynamics is brought out in Chapter 3. Gibb's paradox and the relation of entropy with information theory are discussed in clear and lucid way.

Canonical and grand canonical ensembles and their use in the derivation of Bose-Einstein and Fermi-Dirac distribution form the subject matter of Chapter 4. Chapter 5 is exclusively devoted to partition functions and their applications. Degeneracy of Bose-Einstein and Fermi-Dirac gases are dealt with in Chapters 6 and 7 respectively, which also take account of topics like liquid He, electrons in metals and white dwarfs. Semiconductor statistics, non-equilibrium states, quantum Hall effect, random walk and Fourier analysis of a random fluctuation are covered in the subsequent chapters. Cooperative phenomena and Ising model are discussed in chapter 11 while the concluding chapter gives an account of the modern treatment of the critical phenomena.

The book has been written in a clear and systematic manner. The language used is simple. Problems included at the end of each chapter will add to the understanding of the concepts developed in the text. A list of appendices, including some useful mathematical results and functions, has also been added at the end of the book. The book will fulfil the requirements of the students for whom it is meant.

P.K. Mukherjee

## BOOK REVIEWS

**BASIC BIOPHYSICS FOR BIOLOGISTS** by M. Daniel, *Agro Botanical Publishers*, IV-E/175-176, J.N. Vyas Nagar, Bikaner-334001, pp. 286, Rs. 200.00 (Hard bound)

**M**ANY contributions to biological science have come from physicists and chemists about a century ago. In recent years, the science of biology at molecular level has emerged. The classic compartmentalization is no longer adequate. The problems now confronting biologists require an interdisciplinary approach. Biophysics is but one subject that utilizes recent scientific and technological advances for solving numerous complex problems of living organisation.

The book under review is an attempt to overcome the difficulties experienced by teachers in physics when they give courses in their subject to biology students. The objective of the book is to introduce basic concepts and provide a working knowledge on the relationships between physical properties, chemical constitution and biological function of a living system. It is broadly divided into four chapters. The first half of the book concerns with nature, function and configurations of biological molecules and biomembranes, while the second half summarises the various analytical methods like spectrophotometry and chromatography.

The first chapter discusses the structure and behaviour of matter. The structure of atom is explained in a simple and lucid manner. The definition of various bonds, molecules and forces are easy to follow and well written. Special attention has been paid to hydrogen bonds, apolar bonds and Van Der Waals' forces. The mode of molecular organisation in living matter is the subject matter of second chapter. Cell membranes are basic structures and impart shape and rigidity to cells. It examines various components of membranes and their properties critically. It also des-

cribes various mechanisms of membrane transport like diffusion, active transport, electrostatic interactions, etc. The third chapter reveals many interesting facts about radiations and their interaction with matter. It deals mainly with various changes induced by the electromagnetic radiation and the application of these principles in the structural elucidation of organic compounds in detail. It also presents a brief account of radioactivity, x-ray, laser and their applications. The closing chapter reviews various separation methods. The first part discusses latest chromatography techniques such as HPLC (High-performance liquid chromatography), HPTLC (High-performance thin layer chromatography) affinity chromatography, etc. The remainder of the chapter examines the role of electrophoresis, diffusion, ultracentrifugation and viscosity in the analysis of macromolecules. The five appendices given at the end include the Greek alphabet, list of elements, symbols, abbreviations, Newton's law of motion and laws of thermodynamics.

Although written in an easy to follow style, the book contains numerous typographical mistakes. Due to this lacuna, the language is at times faulty and fails to convey the correct message. Also, the book is expensive. Despite such shortcomings the book meets a long-felt need and research workers in biology and physics will find it a useful reference guide to Biophysics.

Meenakshi Munshi  
Vijay Kaushik

**COMPUTERS: SYSTEMS AND PROGRAMMING** by Sanjay Soni and Vinayak Aggarwal, *Sultan Chand & Sons*, 23, Daryaganj, New Delhi-110002, Pp. 319, Rs. 45.00

**C**OMPUTERS are increasingly being used in various fields.

Knowledge of computers will soon become as basic as reading and writing. People will have to be computer literate to cope with the fast growing technological world. The book under review aims at making students and common people computer literate.

The book has been written primarily to cater to the needs of computer science students of different streams of the University of Bombay. However, students offering computer science of other universities and institutions will also benefit from the book. The book has been divided into seven sections. Each section is further sub-divided into various chapters. Section I deals with all the conventional topics including types and classification of computers, binary operations, Boolean algebra, input and output devices, auxiliary storage devices, software, electronic spreadsheets for efficacious preparation of financial statements, programming concepts and flow charting. Section II includes details, about computer programming in BASIC language. Thirty-one programs have been given in chapter XIV of this section. These programs include prime number calculations, calculation of electricity bills for consumers, payroll calculation, run-rate calculation, and calculations related to bank transactions. Some programs required for examination purposes are also included in chapter XV.

Section III discusses the COBOL language which stands for Common Business Oriented Language. This computer language has important applications in solving commercial problems. Section IV introduces computer database systems having management applications. A brief introduction on word processing systems (word processors) appears in the introductory chapter of Section V. The remaining chapters of this section are devoted to the details about Wordstar, one of the most widely used word processing programs in the world. Eight appendices are given at the end of the book. These include summary of BASIC statements,

## BOOK REVIEWS

commands, functions and summary of Wordstar commands, etc. The book has been written in a lucid and easy-to-understand language. It will also benefit a layman who wants to gain a general computer awareness. Certainly, the book must find a place in the shelves of school and college libraries.

**P.K. Mukherjee**



**PROGRAMMING IN C** by V. Krishnamoorthy and K.R. Radhakrishnan, *Tata McGraw-Hill Publishing Co. Ltd.*, 4/12, Asaf Ali Road, New Delhi-110002, Pp. 169, Rs. 27.00.

**C**OMPUTERS now find applications in many diverse areas. Even changing traffic lights, preparing letters, reports, books, etc., are nowadays accomplished with the aid of computers. The areas of computer application are fast multiplying. Yet, one of the principal applications of computers remains solving problems, i.e., solving those problems which are either too unwieldy or cumbersome. To make use of a computer operations to be performed on it must be described in an explicit manner. Computer programming languages are employed for this purpose. Many computer languages are in vogue today and are suitable for different applications.

The book under review aims at introducing to readers the relatively new computer language called the "C programming language". Originally developed by Dennis Ritchie at Bell Laboratories, U.S.A., around 1972 for use on the UNIX operating system, this programming language has grown a great deal in popularity because it is a clean, concise, flexible and efficient language. A great advantage emerging from this language is that the programs written in C on one system can be run with little

or no modification on other systems. This language is best suited for use in system software work, e.g., for writing compilers, interpreters, operating systems, text editors, and so on. Yet this language has been exploited by many software professionals for a wide range of commercial, scientific and engineering applications too.

The book designed for both beginners and practising programmers introduces the concepts of programming in C in a simple and systematic manner. After the simple C statements the reader is introduced to more complex operations such as string handling, file handling, bit manipulation, recursion handling, and so on. The book has in total eighteen chapters. Ten appendices included at the end contain valuable information, including international references on C language, ANSI (American National Standards Institute) standards for C, the C user's Group (CUG), review of C compilers and utilities and manufacturers of C products. The book contains many useful functions and programs and lays strong emphasis on examples. It can serve as a valuable text in C. Both novice and experienced programmers can use the book to their benefit.

**P.K. Mukherjee**



**STILL RIVER** by Hal Clement, *Sphere Books* (1988), pp. 280, £ 3.50

**C**AN life exist in surroundings different from earth? Of course it can!—we science fiction fans will shout. It is an article of faith in the science fiction community that life can exist in a variety of worlds, under completely varying conditions, and that many different kinds of intelligent species, and technological civilisations can be found in many corners of the Universe. Scientists have speculated that ammonia, being

an excellent solvent for many substances (especially lipids), can take the place of water in life process under low temperatures. Similarly, fluorine and chlorine can take the reactive role of oxygen under some circumstances. Perhaps at very high temperatures, silicon, being tetravalent like carbon, can take its place in life processes, along with sulphur and fluorine playing the roles of nitrogen and oxygen. Perhaps there can be thermo-electric, radiation consuming, superconducting life at liquid helium temperatures. Many such alien chemistries have been postulated, but to weave it all into a coherent story and make it comprehensible to the readers is not easy task. Very few science fiction writers have attempted it, and fewer still have succeeded. Hal Clement, Poul Anderson, Larry Niven, Robert L. Forward, Arthur Clarke, and James White are the only authors (in the opinion of this reviewer) who have succeeded in portraying really alien beings, whether in chemical constitution or appearance and behavioural patterns. Isaac Asimov, while a great science fiction writer, is a miserable failure at depicting truly alien beings. Among those who have succeeded, Hal Clement stands out as one of the very best. His classic novel, *Mission of Gravity* portrayed a low-temperature, ammonia-carbon based alien life process on a very massive, rapidly rotating planet, and is still considered a role model for fiction of this genre. His present book, *Still River* is also quite good.

The protagonists are five—a human being, "Molly" (explicitly identified as carbon and water based, oxygen-breathing, high-temperature (260°K to 315° K), high-gravity (1g) organism) "Joe", a spherical, low temperature (220°K-260°K), low-gravity (0.18g), low-atmosphere, ammonia-carbon based non-breathing type; "Charley", similar to Joe but heavier; "Carol", a low-temperature (240°K-250°K), high-gravity (0.8g), ammonia-based, nitrosyl chloride (NOCl) breathing

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being with a furred skin and two pairs of limbs; and finally "Jenny", a low-temperature, (220°K-260°K), ammonia-based, oxygen-breathing high-gravity (1.85g) centipede-like creature. All are the equivalent of Ph. D. students, at a Galactic University and have been set the task of exploring an "unknown" world called Enigma (very small, very low gravity) in order to account for its anomalous atmosphere.

The world actually is not unknown, but an "exam world" which has been explored by students many times over, but whose records are sealed. The students get into many mishaps, partly because of their physiological make-up. For instance, "Joe" gets blown away by the wind, because on his planet there is no wind. There is a lot of diving into ammonia pools to collect samples, at which "Molly" the human, is a miserable failure as her centre of buoyancy is too high. During her explorations, she gets lost in a cave. (Of course, all the students are in their space armour and all can talk to each other by means of radio and computer translators). In trying to rescue her, first "Carol" and then the other students discover that the entire planet is riddled with interconnected caves of varying diameters. There is an extensive carbon dioxide/methane/ammonia atmosphere within the caves, and it is linked with the outside too. The temperature gets higher as they proceed towards the core of the planet, following an ammonia river (the "still river" of the title) and finally the temperature is high enough for a water/oxygen/nitrogen/carbon dioxide system. All along the way, they find many different kinds of life, (based on very different body chemistries) which puzzle them since

such different varieties of life cannot evolve on a single planet. The planet is also far too small to have developed an atmosphere, but there is one. Finally they realise that all the varying life forms (of many differing body chemistries) have resulted from contamination brought by many differing species of students over thousands of centuries, and the atmosphere is also a result of that life. (the Gaia principle states that life modifies its environment to sustain itself). After reaching the core of the planet which is a cave about 1200 km in diameter, the students are reunited, and after a few more troubles (in which Charley, the large spherical non-breathing type gets badly injured), they succeed in getting away with adequately detailed data for their degrees.

The story is very entertaining, very well told, and full of ingenious scientific twists and turns. The descriptions of the machine systems and tools of the students, and of the physical structure of the world "Enigma" of the cave systems, the somewhat surprising behaviour of large "drops" (a few meters in diameter) which the water/ammonia river becomes as it falls into the zero-g inner cave, all these are given with marvellous technical detail. There are also very interesting psychological traits. The low gravity spherical being "Joe" carries politeness and non-interference in other people's work to a maddening level. The human gets into trouble mainly because of the unbounded curiosity inherited from our simian ancestors. The numerous problems that occur when such widely different Beings have to live together are entertainingly described. However, Hall Clement seems to have slipped a little bit from his usual meticulous attention to

detail. The source of heat as they near the core of the planet is not specified, since of course, the planet does not have volcanic heating. The structure of the planet is postulated to be due to dust particles accreting on a solid ice core which subsequently gets evaporated, leaving a large cavity behind. Well, such an accreted crust will not be rigid enough to sustain such a large central cavity without prior igneous processing, which is ruled out in this case. The microwave system they use for conversation would get impossibly scattered in penetrating the system of caves. And so on. But this is all nit-picking; the story is very well done, and with much more attention to scientific detail than is usually the case.

S. Mohan

### Books received

1. **LABORATORY TECHNIQUES IN CYTOGENETICS AND PLANT BREEDING** by S.S. Choudhary and Prabha Choudhary, *Kalyani Publishers*, 1/1, Rajinder Nagar, Ludhiana-141008, Pp. 58, Rs. 35.00
2. **INTRODUCTION TO COMPUTERS** by N. Subramanian, *Tata McGraw Hill Publishing Co. Ltd.*, 4/16, Asaf Ali Road, New Delhi-110002, Pp. 315, Rs. 33.00
3. **ROCKY SHORELANDS** by Chris Packham, *Collins* (Available from: *Rupa & Co.*, 3831, Pataudi House Road, Daryaganj, New Delhi-110002), Pp. 128, £4.95
4. **ROMPING IN NUMBERLAND** by P.K. Srinivasan, *Alarsri Publications*, Plot 5, Street 25, T.G. Nagar, Madras-600061, Pp. 62, Rs. 20.00
5. **NUMBER FUN WITH A CALENDAR** by P.K. Srinivasan, *Alarsri Publications* (address as above), Pp 76, Rs. 20.00

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