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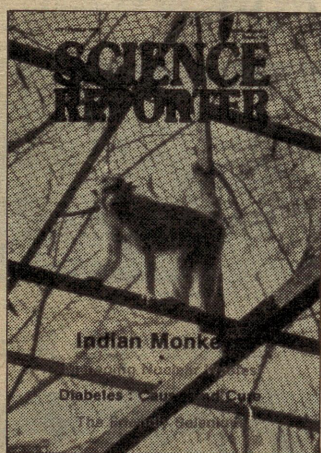
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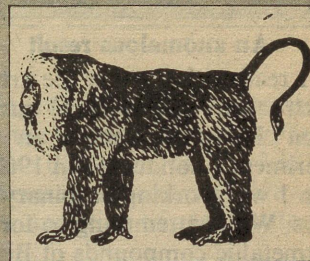
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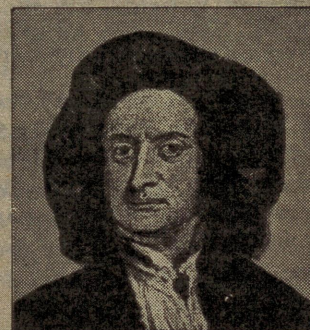
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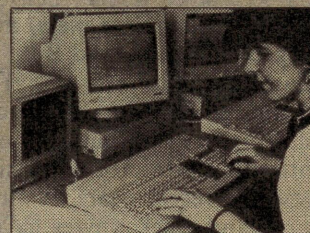
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LETTERS

An anomalous result

Sir, I read with interest the article 'Electrochemically induced nuclear fusion'. It reminded me of an experiment I conducted in 1967-68, when I was working on binary alloys. While attempting to form intermetallic compounds of Bi with Zr, or Ti or Ta, I found that one combination gave unexpected results. My procedure was to mix metal powders (in definite At. %) of a particular grain size (probably 75 μ -using 400 mesh sieve), pack them in a capillary tube and heat it by passing current through it. The method, etc., were reported in *Zet.fuer Metalk*. The unexpected happening was that after the withdrawal of electrode in about 10-15 secs (time not counted) the mixture became red hot with temperature may be around 900°C-1000°C (not measured). The experiment was repeated many a time and the same behaviour was seen. I think only the structure of end product was reported by me in *Solid State Communication*.

I tried to analyse the observations, but could not succeed. With the passage of time, I had to leave research, but this anomalous observation remains in my memory.

Arun Singh
Principal
Govt. Girls College
Seoni 480661
Madhya Pradesh

Biomonitoring of pollution

Sir, Plants to monitor metal pollution by B.N. Behera and B.B. Panda (*S.R.*, April-May 1989) was lucid and informative. Biological monitoring or biomonitoring of pollution has attracted increasing attention in recent years. A number of micro and macrophytes have been used as pollution indicators due to their capacity to accumulate

metals and other pollutants from aquatic ecosystem. Besides, fishes owing to their distribution in all types of waters are very well suited for biomonitoring programmes. Some of the morphological structures like gills are very sensitive to pollutants. Cardiac rhythm and haematological measurements in fishes have been found to be helpful in biomonitoring. A variety of biochemical methods such as the assay of changes in the plasma protein of fishes have been used in biomonitoring studies. With the advent of scanning electron microscope (SEM), it has been possible to study the effect of pollutants on different organs of fishes.

K.S. Bilgrami of Department of Botany, Bhagalpur University, in his presidential address of the XI All India Botanical Conference held at Tiruchirapalli in January 1989, while advocating the biomonitoring programme as less expensive and fairly reliable, suggested that most appropriate approach for biomonitoring should begin with the selection of sensitive/indicator species from every group of biota (i.e., algae, fungi, bacteria, zooplankton, macrophytes, fishes, insects, reptiles and molluscs, etc.) at sites and subsequently by recording their response to different dilutions of the pollutants under laboratory conditions in order to develop a definite protocol.

M.I.A. Khan
SRF (CSIR)

Saptami Moitra
JRF (CSIR)

University Dept of Botany
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More on diseases

Sir, I am a student of B.Sc. (Hons) and a regular reader of *S.R.* for the last four years. The article **Cancer inhibition in food** (*S.R.*, February 1989) by Behera and Panda deserves praise.

The article gives information on how to protect human heredity against the damaging influence of environmental agents. The authors have also given the names of seasonal fruits and vegetables which act as a good chemopreventive agents against cancer and which block the action of a number of carcinogenic agents.

I request you to publish more articles on other diseases like heart disease, tuberculosis, kidney disease and their cure.

Abhay Kumar Sahay
"Sahay Bhavan"
Patna

Smoking—a hazardous addiction

Sir, Special thanks for publishing **Smoking—a hazardous addiction** by K.C. Kanwar and Jyotika Kanwar (*S.R.*, April-May 1989). This educative and informative article informs the smokers that their life is in great danger. Articles of this type are highly useful to persons who have adopted modern way of life.

I hope that you will continue to publish articles on such subjects.

Amitav Ghosh
A.M.C.
Calcutta-700009

References

Sir, *Science Spectrum* of *S.R.* is educative, instructive and interesting. I come across recent developments in science and technology through this section of *S.R.* But I think contributors should give some references at the end of the articles so that we can refer to them for obtaining more information on the concerned subjects.

Akshaya K. Purohit
G.M. College
Sambalpur-768002



Monkey Business

B.K. BEHURA

Macaques are thick-set medium-sized monkeys which inhabit forests and mountains, some of them even live above the snowline

THE macaques or rhesus monkeys are easily distinguished from the Hanuman monkeys by a number of characters, the most important of which are the possession of cheek pouches for storage of food and sitting pads (ischial callosities) with thickened skin. Their stomach is divided as in ruminants. Above all, the face, palm and feet of Hanuman monkeys are black whereas in the macaques they are never black but may vary from brownish gray to pink, flesh-coloured or red. Macaques are at ease both on the ground as well as on the trees. However, when they move on trees, their gait appears to be somewhat awkward and laborious. They breed at any time of the year. The female is not particular in her choice of the mate and when in heat may move from one male to another. Macaques (*Macaca*) are confined to South Asia. Only one solitary species is found in Morocco, Algeria and Gibraltar. This is the only species found in Europe.

The macaques are thick-set

medium-sized monkeys. The Asiatic genus *Macaca* inhabits the forests and mountain areas of China, Japan, India, Tibet, Burma, Malaya, Indonesia, Laos, Cambodia and Vietnam. They stand the cold well, being accustomed to high altitudes, some of them living above the snowline.

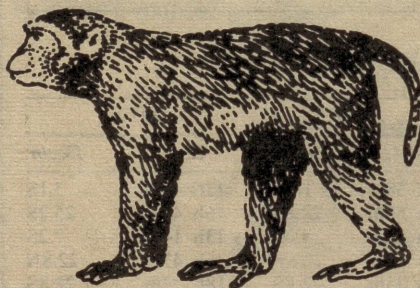


Fig. 1. Rhesus macaque

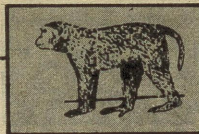
The following species of macaques occur in geographical India: 1. Rhesus macaque, *Macaca mulatta*, 2. Bonnet macaque, *Macaca radiata*, 3. Lion-tailed macaque, *Macaca silenus*, 4. Assamese macaque, *Macaca assamensis*, 5. Pig-tailed macaque, *Macaca nemestrina*,

6. Stump-tailed macaque, *Macaca arctoides*, 7. Crab-eating or long-tailed macaque, *Macaca fascicularis*, and 8. Toque macaque, *Macaca sinica*.

Rhesus macaque

The rhesus macaque (*Macaca mulatta*) (Fig. 1) is the most familiar macaque of northern India and the most common monkey of South Asia. When young, they are caught and tamed and trained to exhibit various tricks. This is the species which is commonly seen with the *bazigars* in north India.

It is a medium-sized monkey, with olive coloured hair covering the upper portion of the body. The face is naked, light pink, flesh-coloured or reddish. The loins, rump and base of the tail are orange-red. The hind quarters are bright red. The hairs on the crown radiate backwards from the head. There is no parting of hair on the head, no whorl or cap. This characteristic feature distinguishes it from the Bonnet macaque (*Macaca radiata*), the common monkey of South India, in which the hair on the



forehead has a distinctive hair parting and a whorl of long, dark hairs radiating in all directions from the crown forms a small cap. The tail is usually half the length of the head and body.

The *Bandar* (Hindi) is distributed over a large area extending from Northern Afghanistan (35° North latitude), through northern and central India, Assam and beyond through Burma (not seen in extreme South), Laos, Cambodia, Vietnam to China (about 40° North latitude). It also inhabits small pockets in Tibet. In India, its southern limit is river Tapti on the west and river Godavari on the east (Fig. 2).

The rhesus macaque lives in diverse habitats—near human habitations in cities and villages, among rocks and cliffs, in the semi-arid regions of Rajasthan and in the mangrove swamps of Sunderbans where freshwater is not available. It lives in the Himalayas, in the pine forests

upto a height of 2,440 meters (8,000 feet) in which some are known to pass the winter. It is a permanent resident in many temples in North India and in the Jagannath temple, Puri, Orissa where it subsists by pilferage and snatching away food from unwary devotees. In Assam, it lives in the fringe of forests and does not enter deep into them.

The rhesus macaque is diurnal. It spends more time on the ground than on trees. However, in the swamps of Sunderbans it is almost wholly arboreal (living on trees). The diet consists of leaves, young buds, flowers, fruits, berries, seeds and bark of over 70 different species of plants, and mushrooms, algae of ponds, insects and spiders. They are known to eat the tender leaves and fruits of mango, fig, banyan, tamarind and the neem tree.

Insects include termites, grasshoppers, ants and beetles. In the Sunderbans, they are reported to feed on crabs and fishes as well. They also eat earth from termite mounds.

They quench their thirst 2-3 times a day by visiting streams and pools. In the mangrove forests of Sunderbans where freshwater is unavailable, they

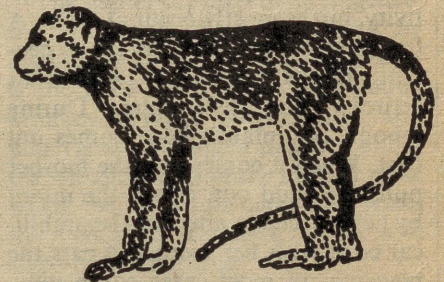


Fig. 3. Bonnet macaque

meet their requirement of water by licking dew from the leaves and eating leaves and fruits.

Both young and adults are good swimmers. They swim in water in a dog-like fashion. In regions where the summer temperature is high, they enter canals and streams to bathe.

They live in groups varying from 5 to 180 individuals. The home range of a group varies from 1 km² to 16 km². A group is composed of adult males, adult females, infants and juveniles. This is quite in contrast with group structure in the Hanuman monkey (*Presbytis entellus*) where a group usually consists of a dominant male, a harem of females, juveniles and infants. Thus the two species differ remarkably in their social habits, although for purposes of foraging a group of rhesus macaque and a group of Hanuman langur may collaborate together to raid an orchard or plantation and separate out at the end of the venture.

The breeding season of the Rhesus macaque varies according to the geographical situation of the place. It is at different times of the year in different parts of India. The peak mating season in India appears to be from November to January and the peak birth period extends from March to May. However, at some places breeding takes place twice a year, the second birth period occurring in September-October. Usually one

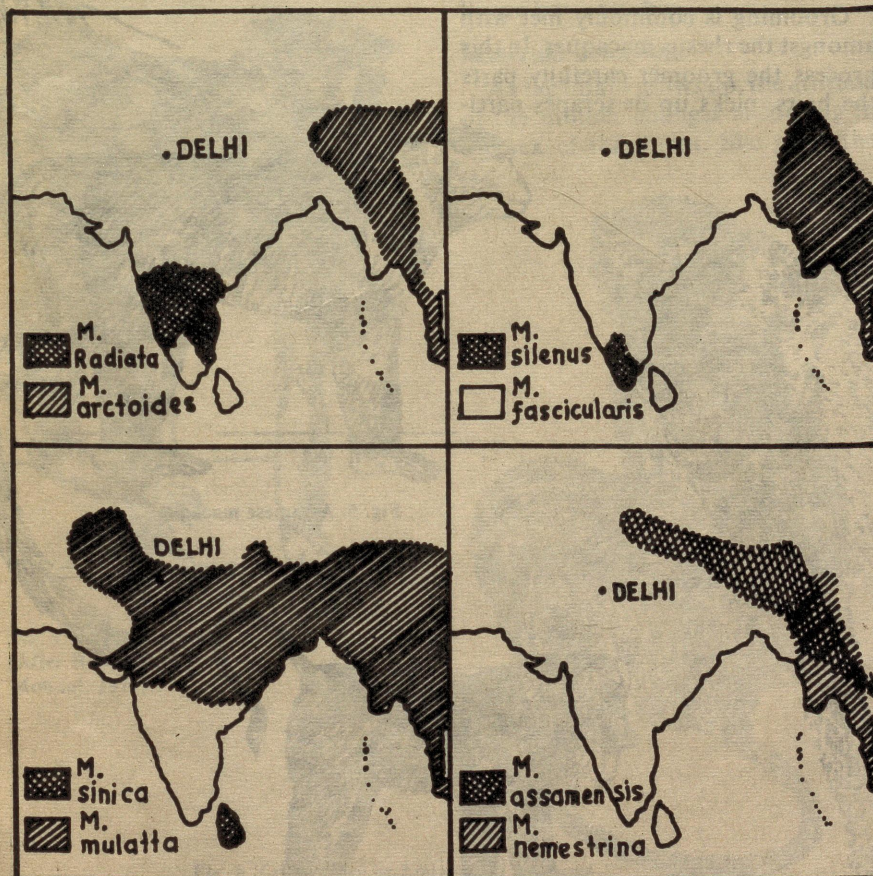


Fig. 2. Map showing the approximate distribution of different species of macaques in South Asia (After Roonwal and Mohnot, 1977)



young is born at a time, twins are a rare occurrence.

The oestrus (period of sexual excitement and receptivity in the female) cycle lasts about 28 days. Sex play is initiated by the male by petting the female and by manipulation of her external genitalia. The gestation period is 139-194 days for males and 145-185 days for females. In captivity, births mostly occur at night. A few days before delivery, the expectant mother macaque somewhat retires from the group. During labour, the infant's head comes out first. When it comes out, the mother pulls the child out, cleans the infant by licking, chews and cuts the umbilical cord with her teeth and eats the placenta, in most cases completely. Lactation lasts 7-14 months.

As a rule, when an infant is born, the group takes little interest in the babe. This is quite in contrast with the situation in a group of Hanuman monkey, *Presbytis entellus*, where the newborn becomes the centre of attraction, especially among the females. Unlike the Hanuman langur, the rhesus macaque mother does not allow other females to handle her infant. In the rhesus macaque, the bond between mother and infant is quite strong. The mother is often seen carrying her dead infant for days

together, 6-7 days or more after death, until it is finally abandoned. Abnormal or handicapped infants are not harmed but given compensatory care primarily by the mother and to a certain extent by other members of the group. When the infant is 3-4 months old weaning begins, but lactation may continue till shortly before the birth of the next infant. In some cases, it continues upto 14 months.

Young males attain sexual maturity at 3½ years, while females start breeding at the age of 3 years. The peak period of breeding in females is reached at 7 years. The males become fully adult at 6 years of age when they have full dentition. A schedule of stages of growth of the rhesus macaque is shown in Table 3. The rhesus macaque sheds hair during summer.

Grooming

Grooming is commonly met with amongst the rhesus macaques. In this process the groomer carefully parts the hairs, picks up or scrapes parti-

cles and either eats or discards them. The popular notion that monkeys look for fleas or lice in one another's skin is not correct. Grooming exercise usually takes place towards mid-day. It varies with rank and position in the hierarchy that exists in the macaque group. Generally adult females gather around and groom other females and their offspring.

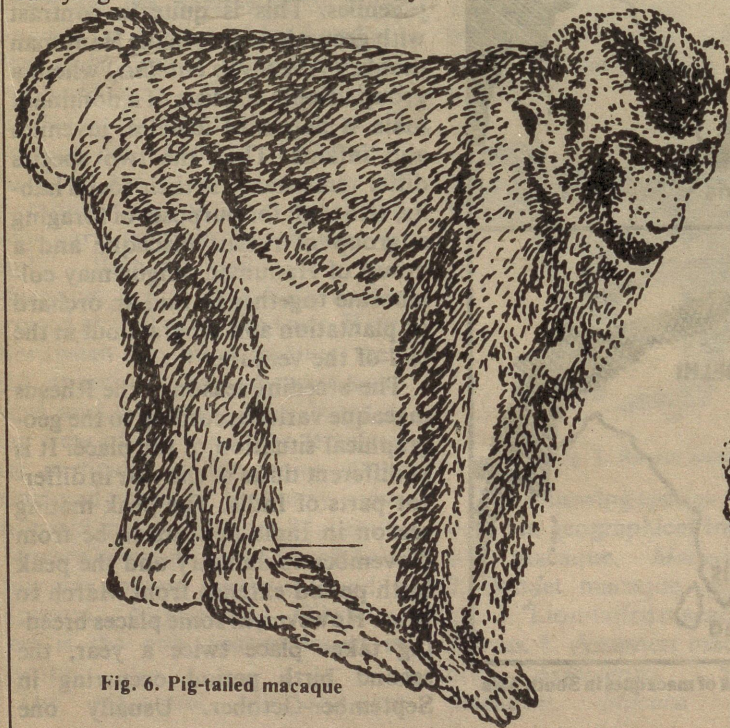


Fig. 6. Pig-tailed macaque

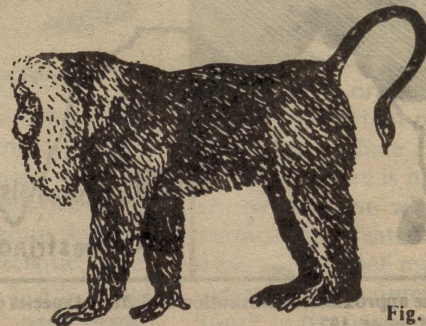


Fig. 4. Lion-tailed macaque

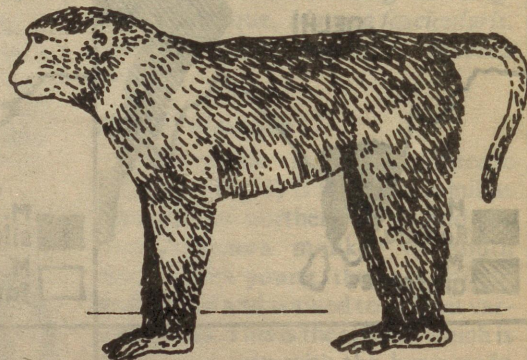


Fig. 5. Assamese macaque



Fig. 7. Stump-tailed macaque (After Roonwal and Mohnot, 1977)



Fig. 9. Toque macaque (After Roonwal and Mohnot, 1977)



Fig. 8. Crab-eating or Long-tailed macaque (After Roonwal and Mohnot, 1977)

Mature females groom males of all ranks, but leader males groom only adult females.

Male-female relationship

Amongst the rhesus macaque, male-female bondage is fluid. On a single day, a male may mate with two different females and a female may

get engaged with three different males. Observers report that single male-single female relationship is seen in less than 50% cases.

Social order

Some kind of social order exists in a rhesus macaque group. A male dominates the troop. There is maternal dominance over female offspring and over males upto the age of 6 years when they are fully adult. This is the time when the son leaves or remains in the group but rises in rank over his mother. Older brothers dominate younger male siblings upto the age of 5 years after which the younger brothers rise in rank. Rank reversal occurs between sisters when the younger sister reaches the age of 3 to 4 years. The relative rank of a brother and sister depends on age until the male sibling reaches 3 to 4 years, when he rises in rank. Dominance relation in the adult male hierarchy is linear but unstable.

Maternal behaviour

As the infant grows up, the attitude of the mother changes according to the sex of the infant. She plays the

role of "punisher" with regard to a male infant and "protector" in the case of a female offspring. Pre-adolescent female monkeys (18-30 month old) exhibit much more attentive maternal care towards infants (1 month old) than males which are pronounced hostile to infants.

Training

The higher the level of intelligence, the smaller is the part played by instinct in an animal and the greater is the need for training. The young monkey is not a born climber and undergoes prolonged practice under the watchful eyes of the mother who, when the occasion demands, seizes the young by the neck or ear and slaps the erring one.

As we go up the evolutionary scale in the primates, in accordance with the normal longevity of about 14 years in lemurs, 27-30 years in macaques and gibbons, 40 years in chimpanzees, and 70-75 years in man, one notices a tendency towards the prolongation of the post-natal period and consequently prolongation of the period of learning.

Play

The rhesus macaque infant begins play activities when about six to eight weeks old. This exerts a significant role in the social life of the macaque. Young monkeys deprived of play become abnormal. Play with peers begins when infants are about 6-8 weeks of age. A play group consists of infants of different age groups. The composition changes several times during the day. Mature females often play with young ones, but never with adults. Adult males also play with juveniles.

Effect of isolation

Social deprivation of an infant from its mother profoundly effects its normal developmental behaviour, although no intellectual deterioration is noticed. Infants brought up under severe isolation become neurotic, asocial, and exhibit deficiencies in sexual and maternal behaviour, etc. They become solitary by nature and exhibit incapability in the sexual act. The presence of the mother reduces the fear response of infants. Even





out a shrill alarming bark to warn others. When attacked, they produce a repetitive cry "Keck-keck". An angry adult male threatening others in the group produces the sound "Hough-hough". Some macaques while feeding produce the sound "Coo-coo".

Association with deer

The Chital (*Axis axis*) understands the call "Coo-coo" produced by the rhesus macaque while foraging and comes underneath the tree occupied by the troop to feed on the leaves, twigs and fruits dropped by them. This association of the Spotted deer with the rhesus monkey in the Sunderbans affords enough warning to the

rhesus macaque when a herd of deer suddenly bolts at the sight of a panther or tiger.

Enemies

The principal predators of the rhesus macaque are the panthers. In the Sunderbans they also fall a prey to tigers, pythons (*Python molurus*). Estuarine or Salt-water crocodile (*Crocodilus porosus*) and sharks. Jackals avoid contact with macaques.

In research

Because of the similarity with the disease spectrum of man, and for var-

ious other reasons, the rhesus macaque has been the most favourite primate in various fields of research such as, ecological, behavioural, psychological, physiological, anatomical studies and biomedical aspects such as, virology, cardiology, neurology and endocrinology. An added advantage in the selection of this monkey is that it is intelligent and curious, soon learns to manipulate simple tools and distinguishes colours and shapes.

The Rh blood factor was first discovered in the Rhesus monkey. It is an important blood antigen found in man and monkeys. The ABO blood group system and Rh system still



Lion-tailed macaque in a zoo



dominate transfusion medicine.

During 1962 India exported annually about 200,000 to 300,000 monkeys most of which were rhesus macaques, at \$ 100 each, for the production of Salk and Sabino polio vaccines and in smaller numbers for biomedical research.

Bonnet macaque

The Bonnet macaque (Fig. 3) is the most common monkey of South India. Its tail is long, almost as long as the length of head and body. Sitting on its haunches, it reaches 60 cm (2 feet) high. A whorl of long dark hairs radiates from its crown in all directions and forms its crown. Hence the name, Bonnet macaque. The bonnet does not, however, cover the forehead, where the hairs are short and neatly parted in the centre.

Its domain is confined to the Southern part of the Indian peninsula and extends as far north as Bombay on the west and river Godavari on the east. Bonnet macaques of Travancore are considered as a distinct race (*Macaca radiata diluta*).

In the area of its distribution the Bonnet macaque is common in the plains as well as in the foot-hills. They are found upto an altitude of 2100 meters above the sea level. They are common in the villages as well as in the jungles, but do not enter deep forests. They are usually seen on banyan trees about 30 m high. It is the Bonnet macaque which is found with the showmen of South India.

It is an omnivorous and voracious feeder. Its vegetable diet consists of leaves, flowers, young shoots, fruits,

nuts and seeds of a large variety of plants. During season, it feeds on mango fruits, wild figs, berries of Lantana, bamboo shoots, tender leaves and fruits of tamarind, mulberry and *Acacia* and fruits of *Ficus*. They also feed on eggs of birds, grasshoppers, flies and sometimes lizards caught by them.

Though arboreal it spends a considerable time on the ground. After foraging in the morning, the macaques sleep on the tree tops for an hour or two at mid-day and continue feeding activities till evening. Before retiring in the evening to the tree-tops for rest at night, they visit a nearby stream or pond to quench their thirst. They are good swimmers and readily take to water.

The Bonnet macaque lives in groups of 3 to 12 individuals. A group consists one to several adults of both sexes, sub-adults, juveniles and infants. In a group, generally more adult males are found than adult females. The home range of a group covers an area of about 5 square kilometers.

The infants of both sexes attain sexual maturity at 2½ to 3½ years. However, the males take another 2-3 years thereafter to become socially mature. Grooming is of common occurrence amongst adult females. Unlike the other species of macaques, the male Bonnet monkey rather than the female solicits copulation. The male licks the urine of the female in oestrus before cohabitation. Thus the

sex urge in the male is olfactory. The male mounts by gripping the female's ankles. Breeding takes place throughout the year, the peak period being September to November. The period of gestation is 5-6 months. Most births take place in February-March. The maternal bond lasts till the infant is about a year old. Infants are able to walk when one month old and commence their play activities.

The Bonnet macaques produce a number of vocal calls suiting the occasion. The sharp alarm call "Char-rac, char-rac" is given out repeatedly at intervals when a predator like a leopard is sighted and continued so long as the predator is in sight. In captivity, the macaque lives 12-15 years, the longest record being 30 years.

Lion-tailed macaque

The Lion-tailed macaque has some distinctive features which separate it from all other macaques and give it the characteristic name. It is a medium-sized monkey with a long face, distinguishing mane formed of long brownish-grey hairs arising from the temples and cheeks. It is glossy black in colour and the tail ends in a small tuft.

Its distribution is confined to the Indian peninsula extending from the southern-most point to 14°N latitude. It was once common in Western Ghats, especially Kerala. Due to destruction of habitat, coupled with killing in large numbers for meat because of its supposed aphrodisiac properties, the macaque populations have been wiped out from vast areas

Table 2. Size and weight of macaques of India (After Roonwal and Mohnot, 1977) (* Both sexes)

	Head and body length (cm)		Tail length (cm)		Weight (kg)	
	Male	Female	Male	Female	Male	Female
<i>Macaca arctoides</i>	55.0-70.0	50.0-57.0	4.0-10.0	1.0-6.0	* 6.0-18.0	
<i>Macaca assamensis</i>	47.6-68.0	44.0-58.7	* 17.8-38.6		6.1-13.0	4.6-6.8
<i>Macaca fascicularis</i>	41.0-65.0	35.4-50.0	43.5-65.5	40.0-54.5	3.5-8.3	2.5-5.7
<i>Macaca mulatta</i>	48.5-63.5	47.0-53.1	20.3-30.5	19.0-28.5	5.6-10.9	3.0-10.7
<i>Macaca nemestrina</i>	49.5-59.5	43.2-56.5 (Malayan upto 60.0)	16.5-24.5	13.5-24.5	4.4-10.9	4.4-14.5
<i>Macaca radiata</i>	51.5-60.6	34.5-52.5	51.0-69.0	48.0-63.5	5.7-11.6	2.9-5.5
<i>Macaca silenus</i>	51.0-61.0	46.0	25.4-38.6	25.4-32.0	6.8	
<i>Macaca sinica</i>	44.0-53.5	43.0-45.0	55.0-62.0	46.5-57.0	4.4-8.4	3.4-4.3



resulting in their struggle for survival in depleted numbers in the Nilgiri hills, Annamalai hills, Cardamom hills and the area near the Periyar lake.

The Lion-tailed macaque is a dweller of the undisturbed dense evergreen forests at heights ranging from 610m-1070m (2000 feet-3500 feet) in the Western Ghats. It lives in groups of 10-20 on the top of trees 20 m or more tall. The food consists of wild fruits, buds and insects. It lives in seclusion and very little is known about its habits. There is no fixed breeding season. Females with newborn infants have been seen in September. They are known to produce at least ten distinct vocal sounds in different situations, varying from a loud "Coo" of a pigeon, a bird-like musical "Pio" to "Coyeh" resembling the human voice calling his companion in the jungle.

Assamese macaque

The Assamese macaque is easily distinguished from the rhesus macaques by the absence of orange red colour on its rump and loins. The general colour of the body on the back is yellowish brown to dark brown. The hairs on the crown appear to have been brushed backwards. The tail is usually one-third to one half the length of head and body taken together.

The domain of the "Assamese macaque" extends over a large area from the Himalayas in Uttar Pradesh, eastwards through Nepal, Sikkim, Bhutan, Assam to Burma, Thailand, Laos, Cambodia, Vietnam and Yunnan (China). It is also found in the southern parts of Sunderbans, West Bengal.

Like the Japanese macaque, *Macaca fuscata*, the Assamese macaque is accustomed to cold, 15°-20° below freezing. In the Himalayas and in Eastern India, they live in heavy evergreen forests at altitudes ranging from 610m to 1830m (2000 feet-6000 feet). In Sikkim and Darjeeling (West Bengal), during severe winter they descend to altitudes 610 m-1220 m (2000 ft-4000 ft.).

Its food consists of tender leaves, buds, fruits and insects. The macaque

also raids maize crops. It lives in small to large groups consisting of 10 to 100 individuals. The presence of a group is known from their musical "Pio" call. Like many other monkeys, when alarmed, they descend to the ground to escape into the dense undergrowth, often to fall an easy prey to the carnivores. Very little is known about their habits. In western Thailand, pregnant and lactating females have been seen during January to April. The Lepchas of Sikkim and Darjeeling hunt "Sahu" (Lepcha) for meat which is believed to have therapeutic value. An Assamese macaque lived in the Calcutta zoo for 6 years.

Pig-tailed macaque

The Pig-tailed macaque is a stout monkey, has long legs and a broad head beset with short, thick, erect hair radiating from the centre of the crown. A V-shaped stripe is noticed on the forehead. The colour of the upper surface is dark-brown to black while the underparts are grey. The tail is short, about one-third the length of head and body measured together, exhibiting the appearance of a pig-tail which is held arched over the hind quarters.

The domain of the Pig-tailed macaque extends from Assam through Burma and Malaya to Indonesia (Sumatra, Borneo and some adjacent islands). It has also been reported from Yunnan (China). The "Kangh" (Naga) lives in deep

Table 3. A schedule of different periods of growth of the Rhesus macaque (*Macaca mulatta*)

Infancy

Second day

Babe begins to sit and crawl on the ground.

First week

Baby begins to ride on the mother's back.

Second-Third week

Infant can climb bushes and vines.

Three weeks

Infant can travel 3-4 m for short explorations under the vigilant eyes of the mother to examine leaves, stones, etc.

Six weeks

Infant begins to play.

Seven weeks

Play between infants and other young ones common.

Three months

Infant leaves mother for short periods to play, explore and feed, but during group movements rides on the mother's back.

Three-Four months

Weaning begins, process may continue till shortly before the birth of the next baby, upto 14 months.

Juvenile or pre-adolescence

Eighteen-Thirty months

Three years

Female attains sexual maturity

Three and a half years

Male reaches sexual maturity.

Adult

Six years

Males fully adult

Seven years

Females attain peak period of breeding.





evergreen forests at elevations of 75m to 1300m. It is omnivorous, feeding on young leaves, fruits, seeds and insects.

The Pig-tailed macaque lives in groups of 3 to 47 individuals. Breeding takes place twice a year, in June and December. Females reach sexual maturity in about 50 months. The period of gestation is 162-184 days. Usually one young is born at a time. The mother eats the placenta before licking and grooming the newborn. Lactation lasts about 8 months. Its vocal call resembles a short "Kang".

This macaque species is now much depleted throughout its range due to severe persecution. In Malaya, the aborigines hunt them for meat. The local inhabitants believe in the medicinal property of its flesh. In eastern India, Pig-tailed macaques are confined to pockets in Assam and Meghalaya. During recent times, some specimens were captured in Mawsynram area in Khasi hills, Meghalaya. Report has it that a group consisting of 26 individuals was sighted in the Hollongapar forest near Jorhat in Sibsagar district of Assam.

The Pig-tailed macaque is intelligent and forms a good pet. In Sumatra, the macaque is trained to pick coconuts. In Malaya botanists train them to collect specimens from tall trees. The longest life recorded under captivity for this macaque species is 26 years 4 months.

Stump-tailed macaque

The Stump-tailed macaque (*Macaca arctoides* = *Macaca speciosa*), as the name indicates, has a very short stumpy tail, about 5 cm in length. The general body colour of the back is brown. The rump is naked around the callosities.

In India it inhabits dense forests of Assam south of river Brahmaputra, from where its domain extends to Burma, northern Malaya, Thailand, Laos, Cambodia, Vietnam and southern China. The macaque is rarely seen and very little is known about its habits. It feeds on leaves, shoots, seeds, tubers and insects. In Assam it has been observed to eat hard seeds of the palm.

The Stump-tailed macaque lives in

groups consisting of 25-30 individuals of both sexes of varying ages. They are noisy when feeding and are reported to be aggressive to man. Some Naga tribes hunt them for meat. The newborn emits an unpleasant body odour.

Crab-eating or long-tailed macaque

This macaque somewhat resembles the Bonnet macaque of South India, but is slightly longer. The general colour of the body is dusky or fawn-coloured. The hairs on the crown flow backwards. The tail is blackish, long, almost as long as or slightly longer than the length of head and body taken together.

Within Indian limits, the Long-tailed macaque inhabits the tropical rain forests of Katchal, Little Nicobar and Great Nicobar islands in the Bay of Bengal. Its range extends to Burma, Malaya, Indonesia (Jaya, Borneo, Sumatra and the smaller islands including the Lesser Sunda islands, but excluding Celebes) and the Philippines. Several specimens were introduced into Mauritius and Kijima island (off the Chita peninsula in Mikaway Bay, Japan). They are found upto an altitude of 2000 meters above mean sea level. Their food consists of buds, flowers and fruits. They also take crabs and molluscs and hence the name. They live in groups of 6 to 30 and are good swimmers and divers.

Toque macaque

The Toque macaque is a near relative of the Bonnet macaque and has similar head dress. It is easily distinguished from the latter by the luxurious growth of hair on its cheeks. The hairs on the crown form a central whorl or cap and hence the name Toque macaque. The faces of the mature male, immature female and infants are gray. The hair on the dorsal side is gray, brown or red. The ventral portion is whitish. The face of mature female, however, is pink to red.

The "Rilawa" (Singhalese) is restricted to Sri Lanka. It lives in jungles feeding on fruits, flowers, buds and insects. Its call resembles "Chrruh,

chrruh". Very little is known about this monkey.

Status

Of the eight species of macaques inhabiting geographical India, four have been listed by the International Union of Conservation of Nature and Natural Resources (IUCN) under different categories of rare animals. The Lion-tailed macaque is regarded as endangered, implying thereby that it is in danger of extinction, while the Crab-eating macaque is treated as vulnerable, indicating that it is likely to become endangered unless stringent conservation measures are undertaken. The Pig-tailed macaque is designated as rare suggesting that only small populations of the species exist. The Stump-tailed macaque is placed under indeterminate category hinting that although suspected to be belonging to either of the three threatened categories, viz., endangered, vulnerable and rare, sufficient information is not available on the species. Under Wild life (Protection) Act, 1972 of the Union Government and adopted by different states, Lion-tailed macaque is placed under Schedule I, Part 1: Mammals, giving it absolute protection, while the Assamese macaque, Bonnet macaque, Pig-tailed macaque and Stump-tailed macaque are placed under Schedule II: Special Game, Part I, whose hunting is restricted and requires special permission of the Chief Wildlife Warden of the State concerned.

Further reading

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Diabetes can be easily detected and effectively controlled with the help of medicines and at times by simply regulating diet

THE RIDDLE OF DIABETES

K.C. KANWAR
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DIABETES mellitus is a clinical syndrome characterized by hyperglycemia (high blood glucose levels) and glycosuria (excretion of abnormally large amount of glucose in urine), and occurs either because of relative deficiency or diminished effectiveness of insulin—a hormone secreted by pancreas—which primarily regulates carbohydrate metabolism. It is one of the most common, chronic, and debilitating diseases that plague mankind. Though diabetes is painless and non-contagious, it is a dangerous life-long malady which warrants immediate attention of health planners.

Diabetes can be easily detected and even effectively contained (though not cured) with the help of medicines and at times simply by regulating diet, yet it is on the rise. In fact, it has already reached menacing proportions all over the world.

The diabetic of today, thanks to our understanding of this disease, can hope to lead almost a normal life, provided he is conversant with the bare essentials of its management, consumes only recommended food and, finally, is regular in taking medicines or injections of the controlling hormone insulin as per doctor's prescription. However, if not initially

managed, diabetes could indeed be dangerous. Before becoming fatal the disease leads to many varied and bizarre vascular, renal, neurological, ocular and muscular complications which directly or indirectly affect virtually all living systems thus making life miserable and bringing death closer.

Diabetes, in a simple language, is a disorder that prevents the body from utilizing a particular kind of food component—the carbohydrates. Carbohydrates normally are first transformed into sugars which are utilized readily for supplying energy, or when in excess are either stored as glycogen in liver or are converted and stored as fat elsewhere in the body. In diabetes, the sugars instead of being consumed for generating biological energy are accumulated in the blood from where they are passed out through urine making it 'sugary'.

History

Diabetes has been known to mankind from times immemorial. The Indian physician, Sushruta, for the first time reported *Madhumeha* (passing out sweet urine) with symptoms of thirst, severe appetite and foul breath. Early Greek physicians

rightly described diabetes as a 'melting down' disease since it was invariably accompanied with loss of weight and strength. Though the relationship of pancreas with diabetes was suggested by the English physician Cawley in 1788, further progress in this area had been tardy till the beginning of the twentieth century. By 1890 experiments on animals had shown that if pancreas—one of the digestive glands—was removed, the animal became diabetic. July 1921 witnessed a breakthrough in diabetes research when Dr Fredric Banting and Dr C.H. Best, both Toronto based Canadian scientists, reported for the first time that exogenous administration of pancreatic extract reduced blood sugar in a diabetic dog. In fact, they were the first to discover insulin—a pancreatic hormone. These discoveries ushered in a new era of hope. Soon it was established that the pancreas of diabetics did not make enough insulin. It appeared as if diabetes was fully understood and perhaps even conquered. Alas, this was not to be so. Further research on diabetes and its management led to new and quick methods to measure glucose in urine and blood which revolutionized the detection and monitoring of the disease.



Fig. 1. Historic event in the history of diabetes. Drs Banting and Best with their dog which they experimented upon on 19 November 1921. The dog was depancreatized prior to administration of the pancreatic extract. Following injection, the blood sugar fell from 330 mg per cent to 170 mg per cent in one hour. This experiment demonstrated that the active principle could be extracted from the fetal pancreas with acetone and alcohol and that it was not destroyed by chloroform and ether.

Diabetes may appear at any time, though most diabetics are above 40 at the onset of the disease. In fact 80% of the cases occur after the age of 50 years and the highest incidence of new patients is in the 60-70 age group. Diabetes is, therefore, principally a disease of the middle-aged and elderly people. Incidence of diabetes does show some age-dependent sex differentiation—young males are more prone to diabetes than females whereas in the middle-age group, women diabetics outscore their male counterparts. Over all, incidence of diabetes, is a shade higher in males than in females. Further, women with repeated pregnancies and those who give birth to large-sized babies are more prone to develop this malady. Why we do not know.

The hereditary pattern of diabetes is rather confusing and complicated. Diabetes is rarely found in new-born babies. Even though the disease is not directly inherited by all the children, all of them harbour the tendency of acquiring it if either or both of the parents are diabetic. For instance, when both the parents are diabetic, only one out of four of their children is likely to develop diabetes for sure, although all would be in a way prone to the disease. In identical twins, both

Prevalence

Diabetes afflicts all races, all religions and both sexes. Over 2% world population suffers from diabetes. In India, incidence of diabetes is about 2.1% in the urban and 1.5% in rural population. Even though the incidence of this disease is somewhat higher in Canada and Japan than elsewhere, diabetes ignores social and economic constraints as well as geographical barriers—it afflicts with equal vengeance both rich and the poor, and blacks and whites. Diabetes mellitus is mostly a disease of adults and its incidence rises with age, yet no age-group is free of it. Obese persons suffer more often from diabetes than those with normal weight. Another interesting observation is that vegetarians are more prone to diabetes than non-vegetarians. Why so is not yet known.

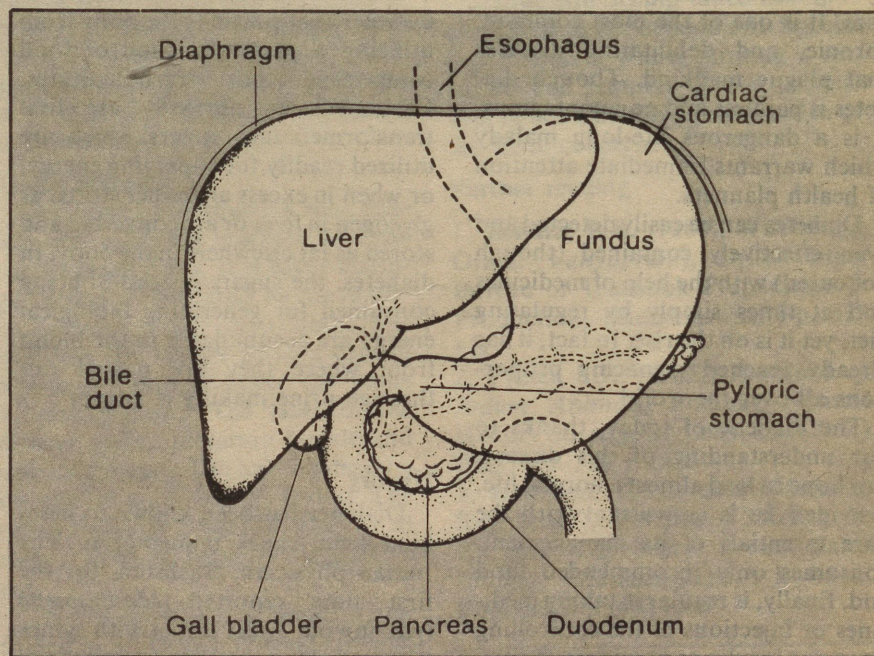
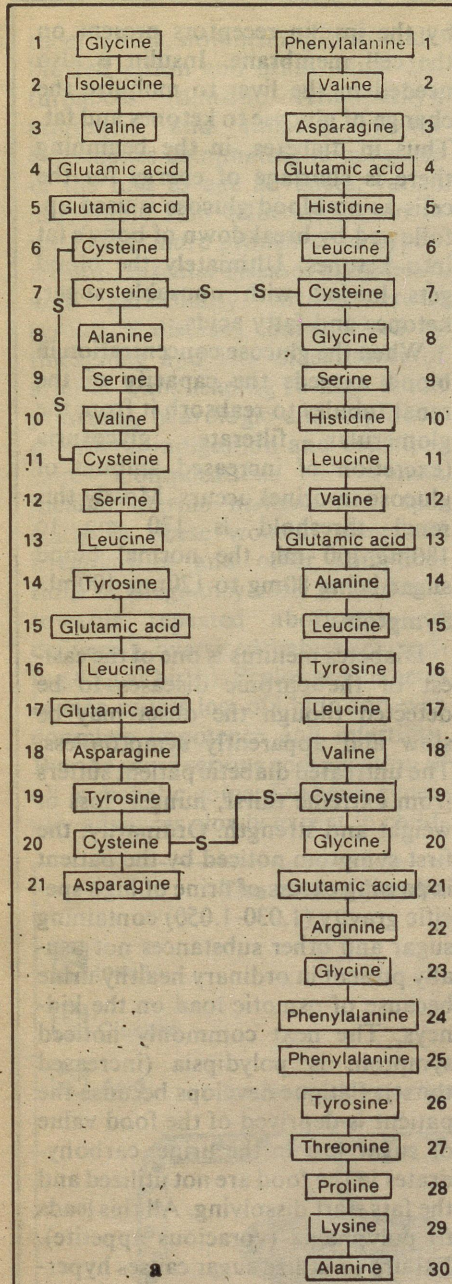


Fig. 2. Diagram depicting positions of stomach, liver, pancreas and duodenum.



are invariably affected. This is not so in case of non-identical twins.

Genetic factors are more important in persons who develop diabetes after the age of 40. Juvenile diabetes, for example, is never hereditary. Some scientists still believe that it is not the passing on of diabetes to the next generation but a failure to pass on the gene that prevents it that is responsible for the hereditary nature of the disease.

Since tendency to develop diabetes is passed on from parents to their offsprings, caution should be exercised while deciding marriages. Marriages between diabetics or even between diabetes-carriers should be avoided to prevent further spread of the disease. Even if one of the two partners is a diabetic, chances are that all their offsprings will be diabetic carriers even though none may develop it. Such 'carriers' should make efforts to keep their body weights below normal because obesity is a triggering factor for the diabetes to show up. Such persons

constituting high-risk group should regularly monitor their urine glucose levels, once or twice a year, and be careful about possible symptoms of the disease.

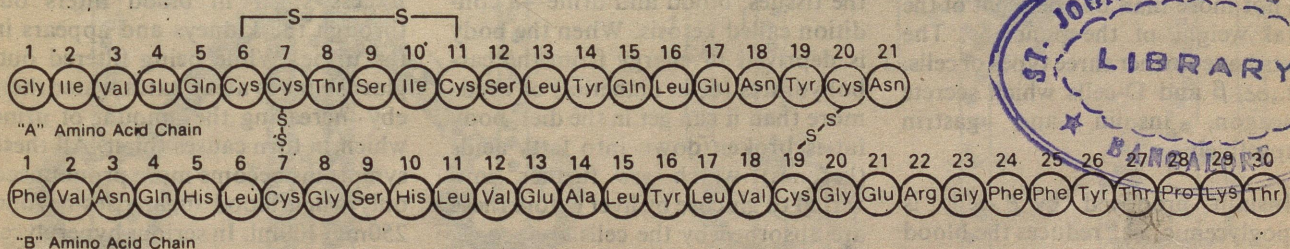
Obesity and diabetes

Obesity is a condition which involves an increase in body weight beyond the limitation of skeletal and physical requirement and occurs as a result of an excessive accumulation of fat in the body. Obesity and diabetes frequently coexist and this close relationship between the two poses questions all of which are still not fully resolved. It is generally believed that both obesity and diabetes mellitus have identical causes, namely impaired functioning of the islets of Langerhans—the endocrine component of pancreas secreting insulin. In both diseases, there is increased sensitivity of the islet cells to stimulation factors and reduced performance rate of the β -cells (specific cells in islets of Langerhans which secrete insulin). The increased sensitivity of

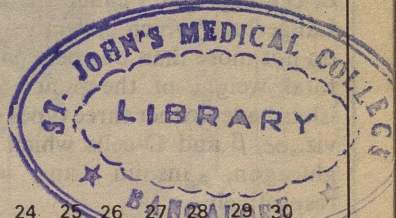
Fig. 3. a & b, Sequence of amino acids in the bovine and human insulin molecules. The insulin in either case consists of two polypeptide chains A & B, each with genetically determined sequence of amino acids. The two chains are held together by 2 sulphur cross-linkages—disulphide bonds between cysteine residues. One of these two bonds occurs between position 7 of both the chains and the other connects position 20 of A chain with 19 of B chain. Another disulphide linkage is present on A chain between amino acids 6 and 11.

Compare the two insulin molecules and note the difference (boxed) in the placement of certain amino acids on Chain A and Chain B. A-chain of the insulins of man, pig, dog, rabbit and sperm whale are identical whereas the B chains of cow, pig, dog, goat and horse are similar. Although insulins isolated from the pancreas of several species are not exactly identical with human insulin but are hormonally active and are routinely administered to human diabetic patients for the management of diabetes.

However, because of amino acid differences on the insulin molecules, about 5% of the human diabetics are either allergic or resistant (or become so during prolonged administration) to insulins procured from other sources. Such patients need to be administered human insulin only which, so far, was very scarce.



	A ₈	A ₉	A ₁₀	B ₃₀
Human	THR	SER	ILE	THR
Bovine	ALA	SER	VAL	ALA
Swine	THR	SER	ILE	ALA



β -cells produces elevated insulin levels, followed by obesity combined with higher rates of lipolysis (breakdown of fats), insulin insensitivity, and decreased glucose tolerance. Diabetes mellitus occurs at a point where insulin secretion in relation to body fat mass is exhausted or becomes disproportionate.

form it cannot diffuse out but stands trapped within the cells thus lowering the glucose availability in the circulating blood. Glucose phosphorylation not only increases the rate of the reaction by which glucose is oxidized but also facilitates its transformation to glycogen in which form it is stored in the body, primarily in liver.

by the insulin receptors present on the cell membrane. Insulin is also needed in the liver to mobilize the change of glucose to ketones and fat. Thus in diabetes, in the beginning there is shortage of energy for the cells as no blood glucose is used up, followed by breakdown of body's fat into ketones. Ultimately the blood gets loaded with unusable sugar, ketones and fatty acids.

When the glucose concentration in blood exceeds the capacity of the renal tubules to reabsorb it from the glomerular filtrate, glycosuria (excretion of increased amount of glucose in urine) occurs. Mostly this renal threshold is 170 mg to 180mg/100 ml; the normal blood sugar being 80mg to 120mg/100ml.

Symptoms

Diabetes mellitus is one of the easiest of the chronic diseases to be detected though the onset may be slow and apparently symptomless. The untreated diabetic patient suffers from extreme thirst, hunger, loss of weight and strength. Ordinarily, the first symptom noticed by the patient is passing excess of urine of high specific gravity (1.030-1.050) containing sugar and other substances not usually present in ordinary healthy urine because of osmotic load on the kidneys. The next commonly noticed symptom is polydipsia (increased thirst). Fatigue develops because the patient is deprived of the food value of sugar lost in the urine, carbohydrates in the food are not utilized and the fats start dissolving. All this leads to polyphagia (voracious appetite). Failure to utilize sugar causes hyperglycemia (excess of sugar in blood). Excess sugar in blood filters out through the kidneys and appears in the urine. While being filtered out, glucose takes away extra water thereby increasing the amount of urine which in turn causes thirst. All these symptoms become more pronounced only when blood sugar rises beyond 250mg/100ml. In serious hyperglycemia, enormous quantity of urine (up to 10 litres/day) containing as much as 500g of sugar is passed out. Other symptoms suggestive of diabetes include recurrent infections of varied type especially more proneness to

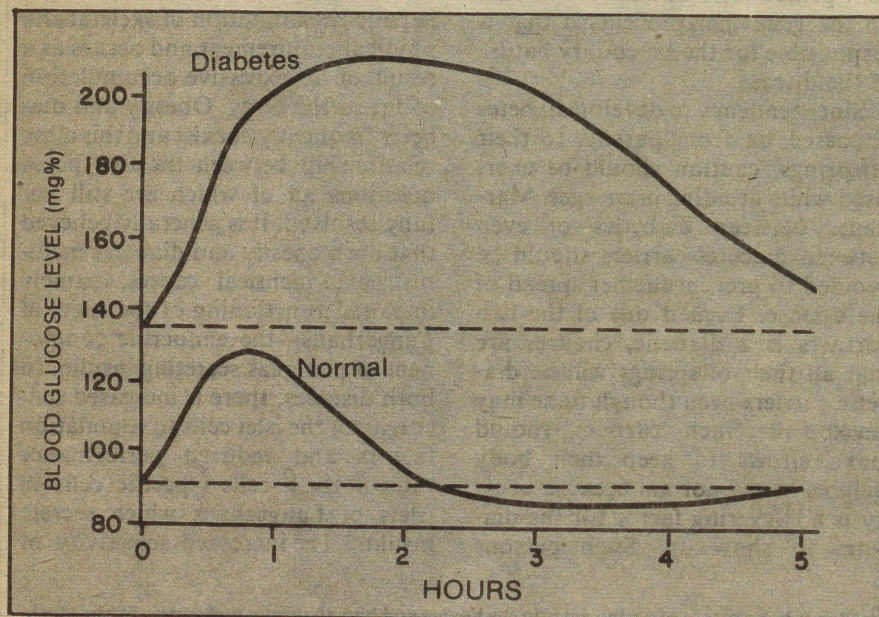


Fig. 4. Blood glucose levels in the normal and diabetic human patients

Pathophysiology

The pancreas is a spongy gland which in the humans is situated just below the stomach in the upper part of the abdomen. It is highly vascular. Pancreas has two parts; (i) the exocrine component comprising the acinar cells which secrete digestive pancreatic juice, and (ii) the endocrine component which is composed of cell aggregates called the islets of Langerhans which collectively make up not more than one per cent of the total weight of the pancreas. The islets have further three types of cells, viz., α , β and D-cells which secrete glucagon, insulin and gastrin respectively.

Insulin produced by β -cells is hypoglycemic, i.e., reduces the blood glucose level by increasing the rate of its utilization, probably by increasing its penetration through cell membranes studded with insulin receptors. Within the cells, glucose is rapidly phosphorylated in which

In adipose cells, insulin causes accumulation of fat by facilitating entry of glucose and its conversion to fatty acids and triglycerides, and by inhibiting the release of fatty acids from adipose cells to blood. In diabetic conditions, there is a failure to synthesize fatty acids and lipids from glucose. In addition, diabetic animals oxidize fatty acids at higher than normal rates, causing over production of ketone bodies, which accumulate in the tissues, blood and urine—a condition called ketosis. When the body is deprived of energy from the carbohydrates (as in diabetics) or needs more than it can get in the diet, body fat is broken down into fatty acids (ketones) which are further converted to glucose by liver before these are absorbed by the cells.

A diabetic who is deficient in insulin (either it being insufficient in amount or ineffective in action for one or more reasons) cannot carry out the direct transfer of blood glucose into the cells which is mediated

tuberculosis, slow healing of wounds, blurred vision and other visual disturbances (diabetic retinopathy), numbness and tingling in the extremities culminating in gangrene of the toes as age advances, varied intractable skin afflictions, pain in the limbs, more proneness to hypertension, vascular diseases of the heart and particularly arteriosclerosis (group of diseases characterized by thickening and loss of elasticity of arterial walls leading to high blood pressure), neurologic and nephrotic disorders, indigestion and constipation. Complications in women include uterine malignancies, especially in obese women, menstrual irregularities and other complications of pregnancy such as tendency towards repeated abortions and delivering oversized babies (exceeding 4 kg at birth). Prolonged diabetes in men causes loss of libido and even complete impotence and infertility. But the more serious complication of all is diabetic coma. Diabetes generally advances slowly except in child-

ren in whom its progress is rather rapid—so rapid that a patient develops acidosis, often vomits and may enter into coma within a few days. The amount of sugar in the blood is a valuable indication of the severity of the disease. The presence in urine of acetone bodies, resulting from the excessive breakdown of fats, is a warning that acidosis and coma are imminent.

Diagnosis

The diagnosis of the disease is made on the basis of many tests, though the family history at times also proves useful.

Urine test is by far the simplest test though not always a deciding one for the early detection of the disease as well for its initial monitoring. There are various procedures which are in vogue for the detection of sugar in urine, such as Benedict's test—a clinical test involving chemical determination of sugar. These days even simpler detection methods are available. Reagent-impregnated paper

strips are available which when dipped in a small amount of urine change colour and the extent of change indicates the sugar level in urine. The disadvantage of urine tests is that in non-diabetics a positive result is obtained if a substance like lactose (in the urine of the lactating women), aspirin, penicillin and large doses of vitamin C or any other reducing agents are present in the urine. Positive urine test could be only suggestive of diabetes rather than its confirmation.

Blood sugar test is more reliable than urine test but, unlike the latter, cannot be done by the patient himself. The amount of sugar in blood under certain standard conditions is a valuable indication of the severity of the disease.

If the diagnosis is still uncertain, a glucose tolerance test is done by administering a particular quantity of glucose to the patient and then testing the blood sugar levels after specific periods. In a normal person, the glucose fasting level is achieved

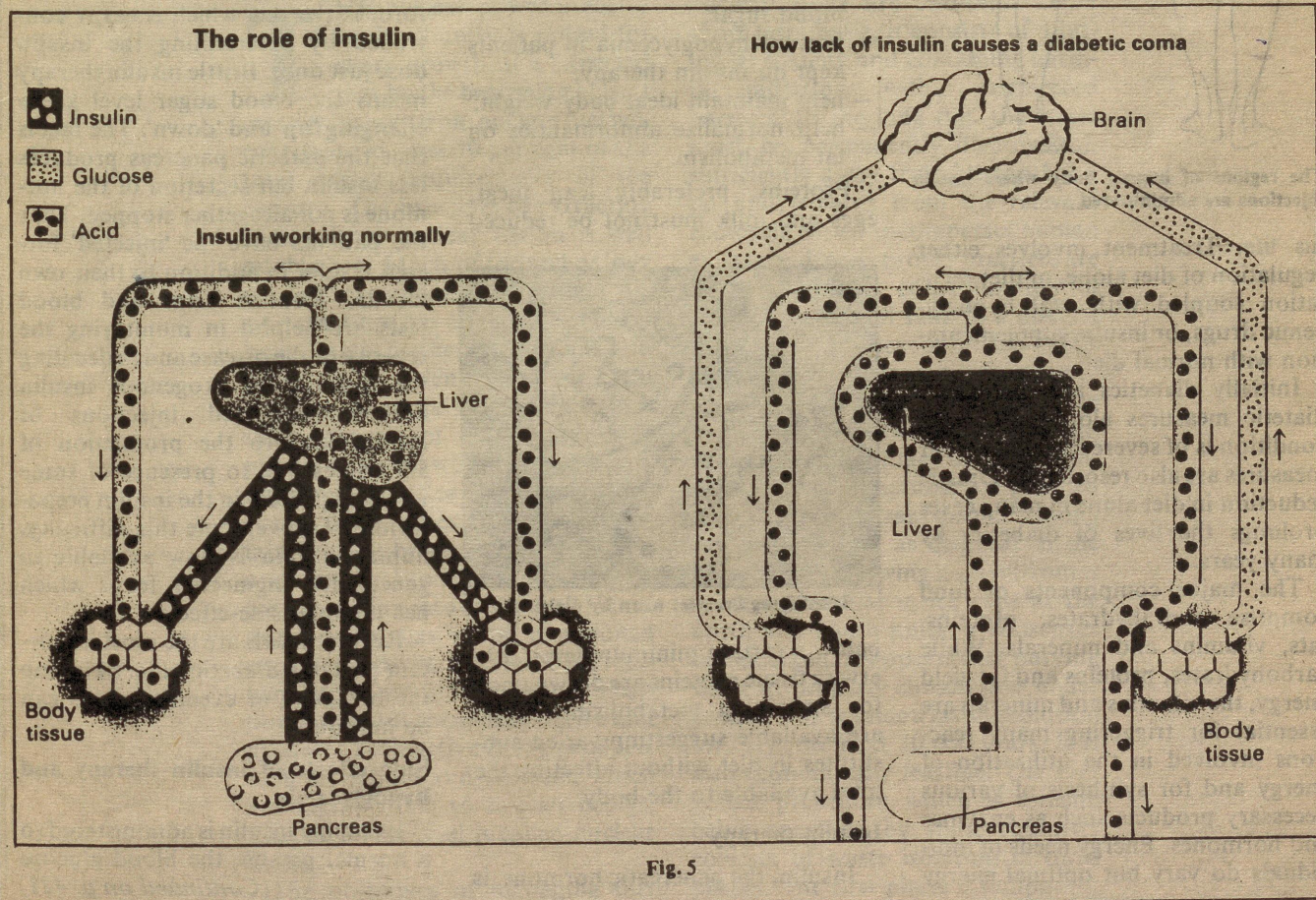
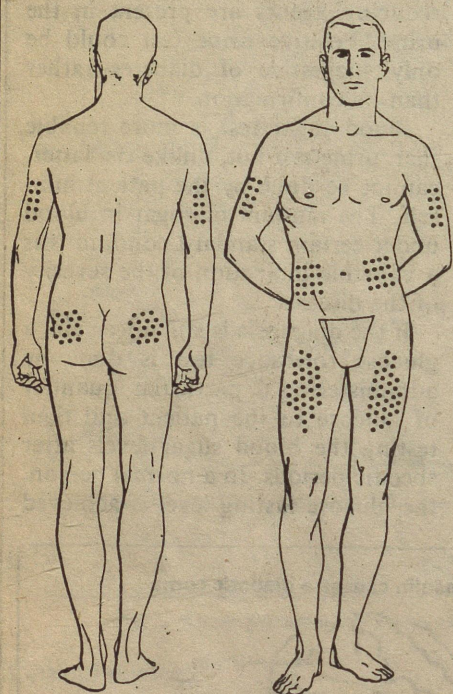


Fig. 5

within two hours whereafter no sugar appears in the urine. But this is not so in a diabetic.

Treatment

There are mainly three methods of treatment and each involves an obligation on the patient to adhere to a dietary regimen for the remainder of



The regions of human body where insulin injections are administered

his life. Treatment involves either regulation of diet alone, or diet regulation coupled with oral hypoglycemic drugs, or insulin supplementation with normal diet.

Initially diabetics are treated by diatetic measures alone and if the condition is of severe intensity, other measures are also resorted to. Drastic reduction in diet alone in many cases prolongs the lives of diabetics by many years.

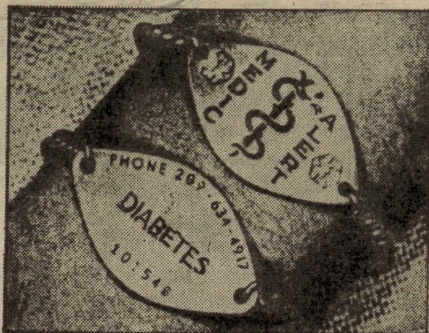
The major components of food comprise carbohydrates, proteins, fats, vitamins and minerals. While carbohydrates, proteins and fat yield energy, the vitamins and minerals are essential for triggering many reactions involved in the utilization of energy and for synthesis of various necessary products such as enzymes and hormones. Energy needs of individuals do vary but optimal energy

requirements are well known and to satisfy the caloric need of the body only weighed diets are recommended for the diabetics. By regulating the amount and the frequency of food intake, particularly of carbohydrates and accordingly adjusting the dose of insulin, or of oral hypoglycemic agents, diabetes can be controlled satisfactorily.

The usual caloric requirement for an adult is 30 calories per kg of weight with an additional 5 to 15 calories per kg for a very active person. The recommended calories for a diabetic are much less—not more than 20 calories per kg wt. A diabetic can have a limited and controlled amount of carbohydrates and liberal amounts of proteins and fatty foods. However, the diet must supply sufficient calories to keep the patient's weight constant. The routine items to be restricted are cakes, soft drinks, sweets, syrups, deep fried foods, molasses, alcohol and even honey. A diet for diabetics should :

- prevent excessive post-meal rise in blood sugar;
- prevent hypoglycemia in patients kept on insulin therapy;
- help maintain ideal body weight;
- help normalize abnormalities on fat metabolism.

Proteins, preferably lean meat, eggs and milk must not be reduced



Identifying bracelet worn by diabetics

below a certain minimum level, otherwise tissue proteins are drawn upon for sustaining metabolism. Tables are available suggesting varied substitutes in diet without affecting the total available to the body.

Insulin therapy

Insulin, the pancreatic hormone, is

an aqueous solution of antidiabetic principle. It is available as a sterile, slightly acidic solution. Since insulin is a polypeptide hormone, it cannot be orally administered because it may break down in the digestive tract into constituent amino acids which lack its efficacy. So it is injected subcutaneously at least once a day. Insulin was first used in the management of diabetes in humans in 1922. Since then it has saved the lives millions of diabetics. If administered under strict medical care, insulin can help diabetics lead almost a normal life. The amount needed depends upon the severity of the disease, upon the quantity and nature of diet and upon the activity of the individual. Exogenous administration of insulin has made it safe for diabetic women to have children. Insulin administration becomes a maintenance therapy for insulin-dependent diabetics who have to take this hormone regularly throughout rest of life.

For insulin therapy, diabetes is classified as stable and brittle. Stable form is the one which is easily controlled by determining the insulin dose just once. Brittle insulin therapy means the blood sugar level keeps changing 'up' and 'down'. The fact is that the diabetic pancreas produces less insulin but secretion of the hormone is not altogether stopped. Thus the patients have the 'injected' foreign insulin in addition to their own insulin. Routine urine and blood tests are helpful in monitoring the severity of the disease and in deciding the quantity of exogenous insulin needed. Repeated injections of insulin lead to the production of antibodies due to presence of some unwated protein in the insulin preparations. To overcome this difficulty, human insulin is now available in genetically engineered form which has minimal side-effects.

Regular meals are the most important part of a diabetic's life. Skipping the breakfast or evening snacks can be harmful.

Side effects of insulin therapy and hypoglycemia

If soluble insulin is administered to a normal person, the blood glucose
(Continued on p. 421)

MANAGING NUCLEAR WASTES

The safety aspects of a nuclear power plant do not end with the proper containment of nuclear reactions. The discarded fuel, called "nuclear waste," is highly toxic to human beings and needs proper management and disposal

K. MURALIDHAR

THE nuclear power industry in the country is poised for sharp growth. It is expected that by the beginning of next century, energy from nuclear fuel will contribute at least 10 per cent of the total energy requirements of the country. The principle of extracting energy from nuclear fission is well established. Much of the technology needed to contain and regulate fission reactions has already been developed and further research is in progress to identify newer and stronger materials. However, the safety aspects of a nuclear power plant do not end with the proper containment of nuclear reactions. Once energy release rates drop below a certain value, it becomes inefficient and uneconomical to capture this energy for conversion into electricity. Hence nuclear fuel has to be abandoned even if its activity remains. This remnant fuel is not fit for power production but is still chemically active and produces radioactive decay products such as radium and caesium, which are highly toxic to human beings. This discarded fuel is called nuclear waste.

The objectives of managing this

nuclear waste are two-fold. On a short term basis, it consists of diluting its toxicity and containing harmful radiations within engineered barriers. In the long run, the waste must be permanently disposed of, sufficiently away from human habitat and isolated from the relevant eco-cycle which encompasses human existence. Unless proper practices are evolved, nuclear contamination of air and water will remain a distinct possibility and prevent further development of nuclear power industry.

Countries which routinely use nuclear power both for domestic consumption and military use have considered various options for planned disposal of nuclear waste. Among suggestions such as disposal in the ocean floor, throwing it off into outer space and burial in ice caps at the north and south poles, a consensus has emerged. It appears that burying waste at properly chosen sites under ground will provide a lasting solution for, say, the next 10,000 years. It is also economically feasible. The suggested procedure which is already being practised by some countries consists of waste isolation in three phases. The first phase is temporary

storage in air-cooled vaults or rooms till the energy-release rate falls below a certain value. The second and third phases consist of packing the waste in closed containers and burying them. The initial burial is closer to the surface of earth, where the waste and its effect on the neighbouring medium can be monitored and controlled, if necessary. This control can be either in the form of air cooling at the surface or by injection of coolant fluids, such as brines, to reduce temperature levels and dilute the toxicity in the event of a leak. The final burial is deep underground in granitic rock formations, which in principle would permanently isolate the waste from human contact. Unfortunately, ideal rock formations do not occur in nature and the possibility of waste leaking past them is quite real. The option of burying energetically useless but chemically poisonous waste underground is safer and cheaper than other alternatives, including the esoteric idea of disposing of waste in the outer space. Some problems still need to be resolved through research.

The plans for nuclear waste disposal in India have not been made public yet. However, in view of the limited choices available, the power plants will have to look for burial sites underground. Quite likely, near-surface burial will be in sand along the coastline and deep surface burial in the interior regions, away from geologically active zones. Potential sites are to be thoroughly mapped for their lithography, rainfall pattern and groundwater flow rates and levels. A proper selection of the site can only be made after each candidate for this task is analyzed, and the scenario with the waste assumed to be buried is quantitatively predicted. A complete picture will emerge only after water velocity, temperature and stresses around the waste region is

predicted, followed by a calculation of the distance travelled by radioactive contaminants in the event of a leak.

An ideal site

What constitutes an ideal site? To answer this question, it is important to understand the physical processes which may occur in the vicinity of a waste container. The size of this container (usually called 'canister') may vary, but it is usually cylindrical in shape, 4m long and about 1m in outer diameter. The canister is made of corrosion-resistant steel, 200 mm thick; vitrified waste in a glass matrix is located in it. During burial, a long cylindrical hole of 2m diameter, either vertical or horizontal, is made. With the container in place, the gap between its surface and that of the hole is packed with clay-type material. The objective of this packing is to reduce velocity of groundwater, as it moves past the container. Several such canisters are placed in an array, with an average spacing of several meters between two of them. This separation is intended to prevent the formation of hot spots or high toxicity concentrations away from the surface of containers due to

merging contaminated streams. Further, one canister will not be placed directly behind another in the path of the groundwater, as temperatures and solute concentrations can then increase beyond acceptable levels due to the addition effect. However, the direction of groundwater flow varies with time, and can be estimated at any instant only on a probabilistic basis. This makes the problem of distributing canisters over an area quite complicated. For example, one can almost be certain that for definite periods of time during a year, a single stream will be contaminated simultaneously by several canisters and toxicity and temperature levels will rise. A successful design should guarantee safety to human population, even in these extreme circumstances.

Near-surface burial

Near-surface burial will usually be close to high density population areas because the waste has to be monitored. The soil in such regions can be expected to be wet at all times. During monsoon, the groundwater level would almost reach the surface, and a net flow would take place past

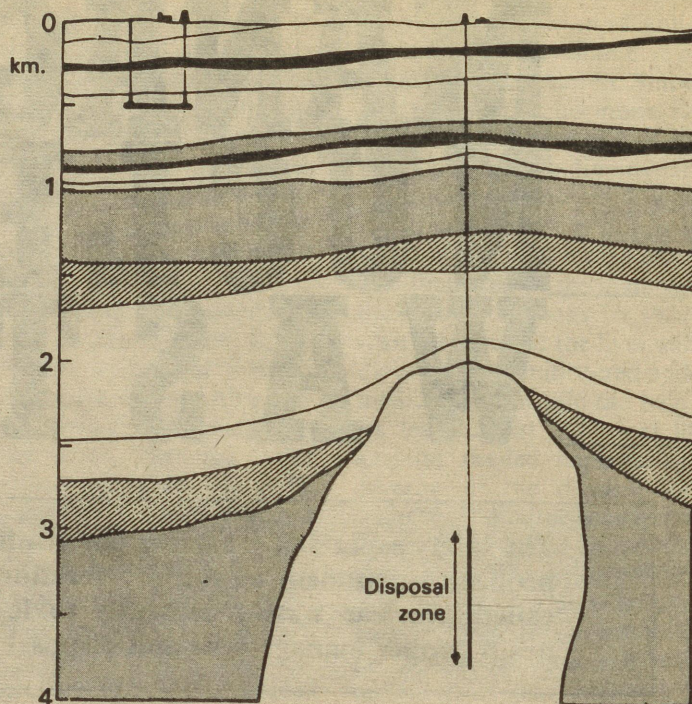


Fig. 1. Schematic illustration of the deep repository concept for long-lived isotopes

the waste canisters. Hence, near-surface burial involves a canister whose environment is soil saturated with water. On a year round basis, this water is mostly stationary. It is occasionally in motion driven by a hydraulic pressure gradient. At the other extreme, deep surface burial will involve dry tuffaceous material or granitic rocks, which will permit very little water movement through them. The groundwater flow at such sites is negligible and any flow that occurs is a portion of rainfall at the surface. To analyze this problem, this natural water movement must first be determined. A comparison of soil and rock structures with reference to their ability to conduct flow is shown in Fig. 3.

Initially, waste canisters would release a large amount of thermal

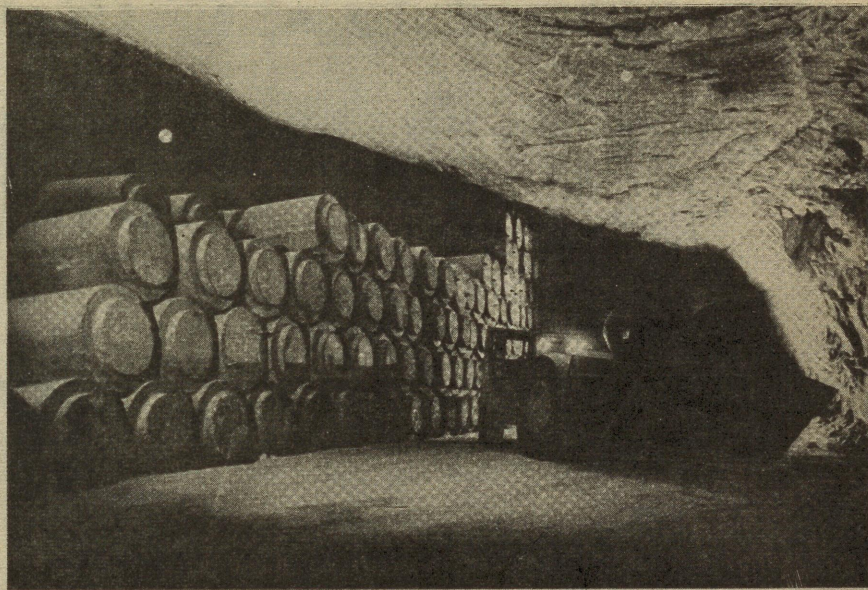


Fig. 2. Nuclear waste containers in an underground cell

and the flow generated by the mechanism given above can be quite strong. These are called buoyancy-driven flows (Fig. 4). They provide an additional conduit or pathway for movement of toxic elements, in case the canister begins to leak. The fluid

canister size, orientation with respect to earth's gravity and array configuration.

Deep surface burial

At large depths under the surface, the formation is dry, and the pores

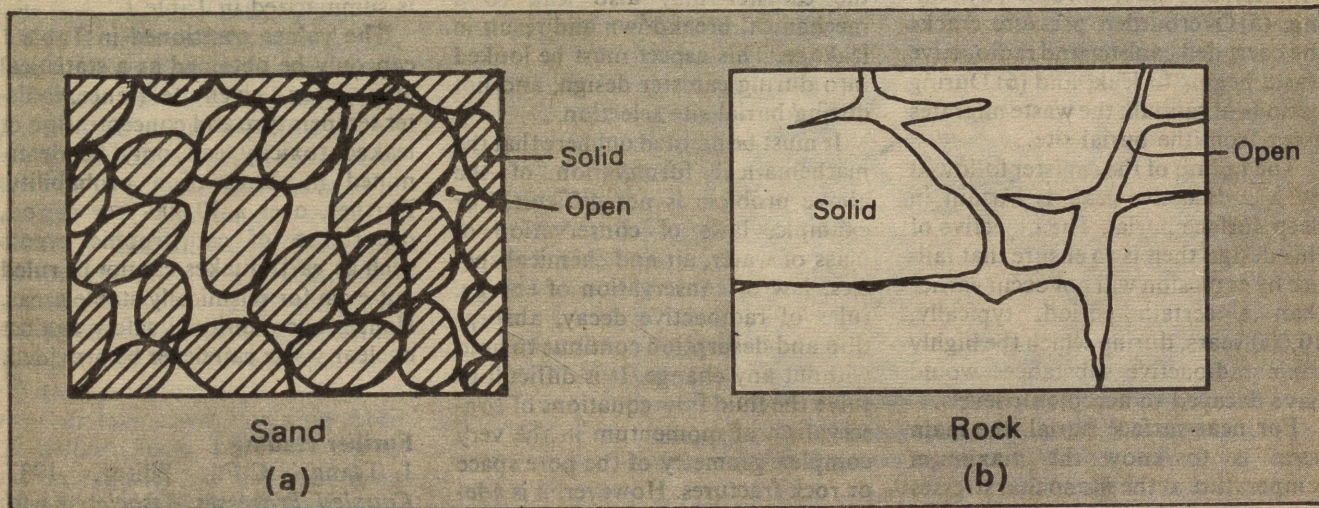


Fig. 3. Comparison of pore structures in soil and rock formations

energy due to residual nuclear reactions within the waste. This will heat water next to the canister surface. Hence, water near the canister will have a lower density than water away from it. This density difference can act as a pumping mechanism and can sustain flow. Temperature differences of the order of 100°C are possible,

movement, whether by buoyancy or by groundwater motion, has the beneficial effect of keeping the canister surface cool. Low temperatures prolong canister life. The extent of cooling provided by the action of buoyancy is strongly dependent on the specific pattern of fluid flow that is set up. This in turn will depend on

(or fractures) in rocks contain both air and water. Even when the canister releases energy at low rates the insulating capacity of air (with respect to water) will lead to a high temperature. The scenario for deep surface burial is likely to be as follows: (1) Canister surface heats up due to low thermal conductivity of air

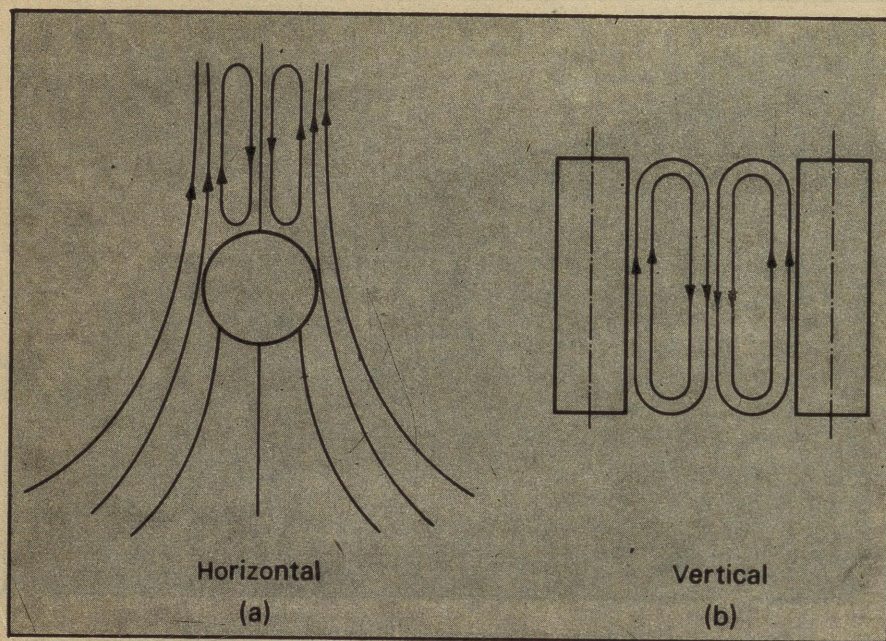


Fig. 4. Buoyancy-driven flow near waste canisters

around it; (2) The high temperature sets air and water in the pores to move; (3) Pore air is chemically active and triggers off the corrosion process of canister cladding; (4) Corrosion is accelerated by the presence of water, and in certain cases, by boiling; (5) Overburden pressure cracks the corroded canister and radioactive waste begins to leak; and (6) During periods of rainfall, the waste migrates away from the burial site.

The failure of the canister followed by a radioactive leak is certain in deep surface burial. The objective of this design then is to ensure that failure by corrosion will not occur earlier than a certain period, typically, 10,000 years, during which the highly toxic radioactive substances would have decayed to acceptable levels.

For near-surface burial, the main issue is to know the maximum temperature at the site so that stresses

arising from differential thermal expansion of the clad material is kept to a minimum. Usually, the period of this burial is limited, around 50 years, and leakage is a secondary issue. Of course, temperature gradients within the canister may also lead to a mechanical breakdown and result in leakage. This aspect must be looked into during canister design, and not during burial site selection.

It must be pointed out here that the mathematical formulation of the above problem is not difficult. For example, laws of conservation of mass of water, air and chemical species, law of conservation of energy, rules of radioactive decay, absorption and desorption continue to hold without any change. It is difficult to solve the fluid flow equations of conservation of momentum in the very complex geometry of the pore space or rock fractures. However, it is ade-

quate to use volume-averaged momentum equations of the form, "velocity proportional to pressure gradient", in this analysis. The ratio of velocity-to-pressure gradient is called hydraulic conductivity, and depends on the fluid, say, water, and the choice of disposal site. The adequacy of the above formulation has been extensively tested using tracer tests. In these tests, a recognizable foreign matter is injected at a point underground and its movement is followed over a long period of time. These measurements when compared with the predictions of the theory, have confirmed the validity of the above approach. However, universal solutions cannot be obtained with these equations and analysis must necessarily be performed for each individual site. The variation in parameters possible for this problem is summarized in Table 1.

The values mentioned in Table 1 can only be obtained as a statistical average for a given site. Hence, canister temperature and concentration of leaked toxicity can only be determined in terms of a probability. Further, over a 10,000-year period, occurrence of catastrophic events such as earthquakes cannot be ruled out even for seismically stable areas. Hence, unconditional safety against nuclear waste can never be provided.

Further reading

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2. Chapman, N.A. and I.G. Mckinley, 1987, *The Geological Disposal of Nuclear Waste*, John Wiley, New York.

Table 1

Energy release rate per container	(Initial)	1000 W
	(After 1000 years)	0.1 to 1 W.
Groundwater velocity	0.001 to	1 m/s
Hydraulic conductivity	10^{-9} to 10^{-13} m ² /Pas.	
Degree of water saturation	0.1 to 1	
Diffusivity in water	Thermal	$15 * 10^{-8}$ m ² /s
	Na ⁺	$15 * 10^{-10}$ m ² /s
Absorption coefficient in mass transfer		10^{-3} to 1 m ³ /kg

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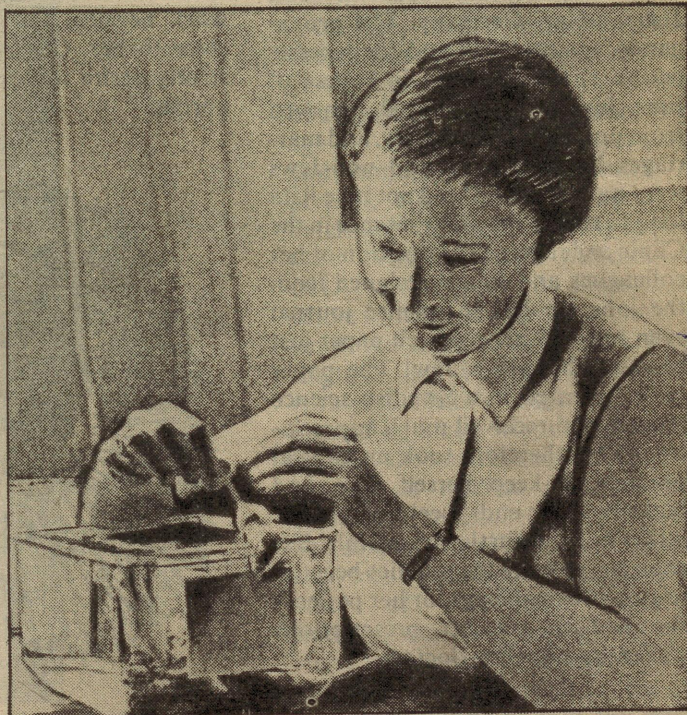
Rita Levi-Montalcini and chick embryos

WHILE the British planes bombed the Italian town Turin every night, Hitler's German army won battles after battles, and Jews were under constant threat of life and imprisonment, a 25 year old Italian Jewish girl, with only a basic degree in medicine, was busy attacking a small medical problem: How do nerves evolve in a chick embryo? She had set up her own small laboratory in a farm house atop a hill, some kilometers from Turin, where her family had taken refuge. A small old microscope, a sewing needle, a stone to sharpen the needle, some alcohol to keep it sterile and an incubator were all that formed her laboratory equipment. While there were food shortages everywhere, she used to cycle from one farm house to another to collect eggs for her experiments. After the experiments the eggs were scrambled to form omelette and served to the family! What she found during those dark days of the Second World War became later the basis of her Nobel Prize-winning discovery of the Nerve Growth Factor (NGF). It has turned out to be a revolutionary discovery with wide-ranging implications in several branches of medicine. That girl was Rita Levi-Montalcini.

Rita Levi-Montalcini was born with her twin sister Poala on April 22, 1909 at Turin, Italy. Her father was an engineer and mathematician and her mother a simple kind soul. Her father had no faith in any religion and was keen to develop his children's interest in culture, human values and science. He never inspired them to go after wealth or power. But he was averse to give his daughters higher education because his own highly educated sisters had family problems. Moreover, in those days, girls were not supposed to receive education beyond a particular stage.

Even in schools they were taught separately. While boys were taught mathematics and science, only language and literature were taught to girls. In such an atmosphere, Rita's elder-sister and Poala had a smooth sailing because the former wanted to become a writer and the latter a painter. The problem was with Rita. What would she like to become. She

was also not interested in marriage and babies. Eventually she could not stand isolation any more and on her mother's goading took courage to tell her father that she was keen to pursue higher education. Within some months she learnt Latin, Greek and mathematics and passed the high school examination. Meanwhile the desire to become a doctor took hold of her after she saw the suffering that her governess underwent due to stomach cancer before she died. Rita joined the Institute of Anatomy, Turin School of Medicine, to take up medicine as a



Young Rita Levi-Montalcini conducting research on nerve centers using mouse tumours at the Washington University, U.S.A.

had shown no special talent either in art or literature or sports. She was somewhat interested in philosophy. At one time, she also fancied to become a writer after reading the inspiring novels of the Swedish Nobel-Prize-winning writer, Selma Lagerlof. In fact, the ideal of the three sisters was to follow in the footsteps of the famous Bronte sisters.

So at the age of 20, Rita found herself isolated from her talented sis-

career. Here she met the famous Prof Giuseppe Levi on the very first day. Prof Levi was an outspoken and blunt person and a hard taskmaster to boot. He openly called her first research work "trash" and considered her unfit for research. Rita came to his notice when she performed her second assignment efficiently. From that time on a relationship of mutual regard developed between the two which con-

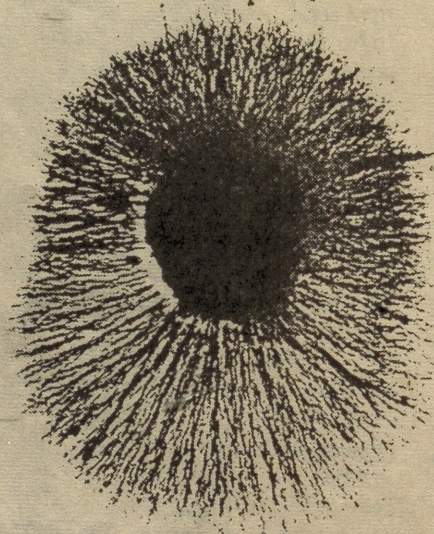
SCIENCE FOR THE YOUNG

tinued till his death, about 30 years later. Under the guidance of Prof Levi, Rita learnt how to approach a research problem in a rigorous manner and acquired the basic skills in embryological research.

In 1936, after taking a degree in medicine, Rita joined the Clinic of Neurobiology and Psychiatry of the University of Turin. She began the study of the nerve centers of chick embryos here and would have continued but for the change in the political climate that occurred in Italy before the Second World War. Under the dictatorship of Benito Mussolini, Italy had sided with Adolf Hitler's Nazi Germany. The propaganda against Jews and their persecution spread to Italy in course of time. Jews were persecuted, removed from positions of authority, and marriages between Jews and non-Jews were not allowed. It did not take Rita long to realise that her presence in the Clinic endangered the position of her colleagues and so she resigned from the job. An Italian science journal even rejected her research paper just because she was a Jew! The paper later appeared in a Swedish science journal and received much appreciation. Rita therefore took up clinical practice to keep herself busy and make both the ends meet because her father had died in the meanwhile. But soon she gave up the practice because to procure medicines for her patients she had to get her prescriptions signed by non-Jew doctors.

In that climate of uncertainty and mistrust, when the Nazi Germany was invading one country after another, Jews were living under the constant threat of persecution and war clouds were hovering over Italy, Rita found herself totally isolated from her colleagues and work. She could not understand what she should do with herself. It was only when one of her previous classmates paid a visit to her and suggested that she should do research within the means available at her disposal, like the great neurobiologist Ramon y

Cajol did, that she was inspired to try her hand at research again. Her childhood desire to go for an adventure to unknown lands acted as a strong motivating force. She decided to redo the experiments on the development of nerve centers in chick embryos conducted by the American embryologist Viktor Hamburger of Washington University. For the experiments the only expensive equipment she required was a good, powerful microscope to examine the nerve developments in the embryo. After much search she managed to procure an old microscope and began to conduct research in her own bedroom. Her mother supported her work because she could then stay close to her. Otherwise, Rita had a strong desire to pursue her interests abroad.



The nerve mass—ganglion—formed a dense halo of nerve fibres in the presence of the Nerve Growth Factor

Thus began Rita's research in the war-torn Turin. Curfews, shortages of food and water, frequent electricity breakdowns and blackouts plagued her research. Whenever the British planes came to bomb Turin and sirens were sounded, Rita would rush down to her cellar with the only things she considered precious in her life—the microscope and the sections of embryos. When the news came that the Italian army would take over

the town, the family shifted to a farm house atop a hill, some kilometers away from the town to escape persecution. But Rita did not give up research. Day in and day out, she would peep through her microscope and patiently watch the development of nerves in the embryos. Two things became evident to her. First, nervous system was not a fixed and rigid system as the medical text-books had made her believe. Second, Prof Hamburger's interpretations of his own experiments were wrong. She had observed something which Prof Hamburger had missed. But when her experiments were in full swing, the news came that German troops were likely to invade Turin because Mussolini had resigned, and Italy had withdrawn her support to Nazi Germany. In 1943, the family shifted to Florence, where it took shelter under an assumed non-Jew name. When British troops took control of Florence, a large number of refugees poured into the city. Rita became a Red Cross nurse to look after the refugees. For the first time she saw human misery when a plague raged the refugee camp.

After the war when Rita and her family returned home she decided to go to the United States to pursue research. When Prof Hamburger came to know that her interpretations of his experiments were different from his he was keen to have her in his group at Washington University so that it could be decided who was right. In 1946 Rita set sail for St. Louis, U.S.A., and joined Prof Hamburger's research group. Although she had originally come to St. Louis for some months only, she stayed on to continue her experiments for the next 30 years. It was again while checking on the experiments of Prof Hamburger's former student, Elmer Bueker, that she observed the anomalous behaviour of nerve cells not noticed till then. She saw that nerve fibres sprouted when nerve cells of chick embryos were grown on mouse

SCIENCE FOR THE YOUNG

tumours tissues. At that time the growth of nerves was a mysterious subject and scientists, including Prof Hamburger, believed that some thing till then unknown to science was responsible for their growth. When

In 1952, Rita went to Rio de Janeiro, Brazil. During her air journey she carried in her coat pocket two white mice afflicted with tumours. It was in the laboratory of her friend, Herta Meyer, she re-did her experi-

millilitre of culture solution produced the growth of nerves. Back in Washington University, Rita conducted further studies on the Nerve Growth Factor (NGF) with Stanley Cohen, who had meanwhile joined her research group. She and Cohen went on to isolate the NGF. Both also discovered two sources of the NGF: snake venom and male mouse salivary glands, which have been frequently employed in further research in the field. Cohen went on to discover the gene that codes for the NGF, a specific chemical that blocks the activities of the NGF, and several other growth factors of immense importance to medical science.

In fact, further researches have shown that the NGF plays a vital role in the immune system of a human body giving a concrete evidence to an age-old belief that the psychology and immune system are linked. At present, efforts are in progress to determine whether the newly synthesised NGF (through recombinant DNA techniques) is biologically active or not and whether it could be employed to cure Alzheimer's, Huntington's and Parkinson's diseases. Although Rita's basic discovery opened up a new window in medical science, she herself was subsequently ignored in medical research. The credit for the discovery of the NGF was denied to her! Her paper was not even mentioned in the reference literature of subsequent research. Initially, she tried her best to convince the research community that she alone was responsible for the discovery. But nobody paid any attention to her. Eventually, she became sick and gave up her efforts to convince people. In frustration she even gave up doing research on the NGF.

Meanwhile, in 1961, the lure of her home and mother brought Rita back to Italy. Initially, she went on a visiting fellowship to work at the Neurobiology Research Center of the National Research Council, Rome. In course of time she set up the Laboratory of Cell Biology there and became its director. She trained a large number of young scientists in



Rita Levi-Montalcini—"I don't work for the sake of mankind; I work for my own sake"

Rita showed her results to Prof Giuseppe Lèvi, who had come to the United States on a short vacation, he simply scoffed at her hypothesis that some chemicals released by the tumour cells were responsible for the growth of nerves. But Rita had the courage of conviction behind her and she was bent upon identifying the chemical that caused the nerves to grow.

ments. She put the tumour cells near a single nerve mass-ganglion in a culture dish. In ten hours, the nerve ganglion formed a dense halo of nerve fibres which radiated out like rays from the sun. The tumour cells contained the substance which triggered off the nerve ganglion to produce nerve fibres. The substance, called "Nerve Growth Factor", was so powerful that one billionth of a gram in a

the field of neurobiology. In 1972 she began to conduct research on the NGF—her first love with renewed zeal. This time her efforts were directed at understanding the action mechanism of the NGF at molecular level. The first ray of recognition for her discovery of the NGF came in 1986 when a conference was organised in her honour in Monterey, Canada. Soon after, the 1986 U.S. Laskar Award was presented to her. And the biggest recognition came when she was awarded the 1986 Nobel Prize in medicine or physiology for the discovery of the NGF jointly with Stanley Cohen for his further work in the field. Rita became famous overnight and praises were showered on her from all corners of

the world. Today, in the field of neurobiology no research paper is published without referring to her pioneering work!

"I don't work for the sake of mankind; I work for my own sake", said Rita in a recent interview. She feels that she could attain what she has in life today because she has a knack of underestimating the obstacles in her path and has the remarkable courage to stick to her own convictions. Today, at the age of 80 she is still active in research. A blunt and straight forward person, she is still single and lives with her twin sister Poala, a famous painter now.

Dilip M. Salwi

soaps which are salts of fatty acids.

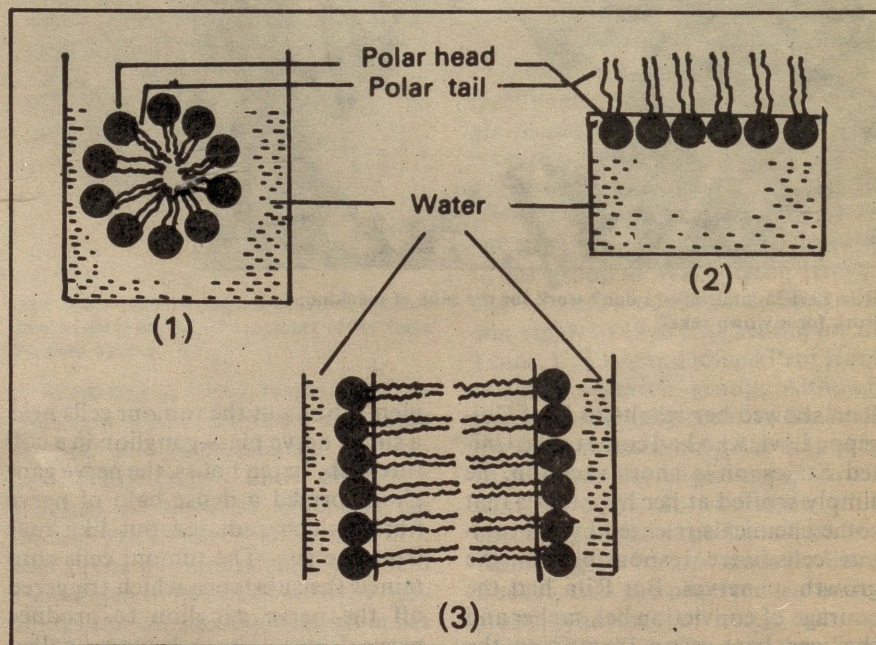
The specific biological function of a lipid broadly depends on the class to which it belongs. Esters of long chain fatty acids and glycerides, particularly triacylglycerols, which are quite abundant, serve as the most important storage form of chemical energy. In some animals, for example, seals, walruses, penguins and other warm-blooded species, triacylglycerols stored under the skin also serve as insulation against very low temperature. Waxes are esters of long-chain saturated and unsaturated fatty acids, having 14 to 36 carbon atoms, and long-chain alcohols having from 16 to 22 carbon atoms. These provide a protective film on skin, hair, wool, feather and plant leaves. Some chemicals remove these lipids, thereby exposing the living organisms to hazard. Waxes are also used in very large amounts in marine life in the form of storage fuel in plankton organisms which are consumed in the oceanic food chains. Phospholipids and sphingolipids serve as the constituents of membranes which have very complex

Lipids and biomembranes

LIPIDS are a group of biomolecules which are water-insoluble, oily or greasy organic substances that can be extracted from cells and tissues by chloroform, ether, benzene and other nonpolar solvents. Although lipids are a distinct class of compounds, they often occur in combination with the member of other classes of biomolecules, furnishing hybrid systems, such as glycolipids, which are composed of carbohydrate and lipid groups, and lipoproteins, which contain both lipids and proteins. In such systems, the distinctive chemical and physical properties of the individual components are blended to suit the specific biological functions.

The most satisfactory classification of lipids is based on their backbone structures. One group, called "simple lipids", does not contain fatty acids and the compounds of this class do not undergo alkaline hydrolysis. The other group, known as complex lipids, which contains fatty acids as components, includes the acylglycerols, phosphoglycerides, the sphin-

golipids, and the waxes. This class consists of saponifiable lipids, undergoing alkaline hydrolysis to form



Figs. 1, 2 and 3

function. The nonsaponifiable lipids are present in the form of steroids and terpenoids.

It is apparent that lipids play extremely important roles in the normal function of a living organism. In recent years, considerable interest

be mentioned that membranes are not simply inert skins holding the cells together but their function is quite complex. They contain enzymes, some acting on substrates outside the membrane and others on substrates enclosed within compart-

ment molecules which triggered off disturbances by altering the membrane permeability, thereby causing the cell's death. The same result was produced by other unfavourable conditions as well.

The immediate causes of membrane lesions were postulated to be: (1) lipid peroxidation, (2) the action of membrane phospholipases, (3) mechanical distension of the membranes, and (4) adsorption of certain foreign proteins on their surface.

Many diseases have been found to be accompanied by an increase in the lipid peroxidation rate. The use of antioxidants has a beneficial effect in such cases. Researchers of Biochemistry Laboratory of Moscow Second Medical Institute, have established that the toxic effect of carbon tetrachloride, an industrial chemical, is coupled with a remarkable activation of lipid peroxidation in liver cells. The administration of antioxidants to animals before poisoning not only lowered the level of peroxidation but also prevented the damaging effect of the chemical. The activation of peroxidation during different diseases underlines the involvement of certain common mechanisms. Products of lipid peroxidation are capable of transporting hydrogen ions across the lipid bilayer. The peroxidation makes pores in the membrane, thereby making it permeable to potassium ions. And once the electroinsulation deteriorates, a current is generated by ions transported across the membrane and the electric breakdown of the lipid bilayers becomes the main cause of their permeability.

Considerable knowledge about lipids has been gained over the years and a new methodology of research is emerging in which lipids are progressively becoming the target of joint studies by biochemists and biophysicists.

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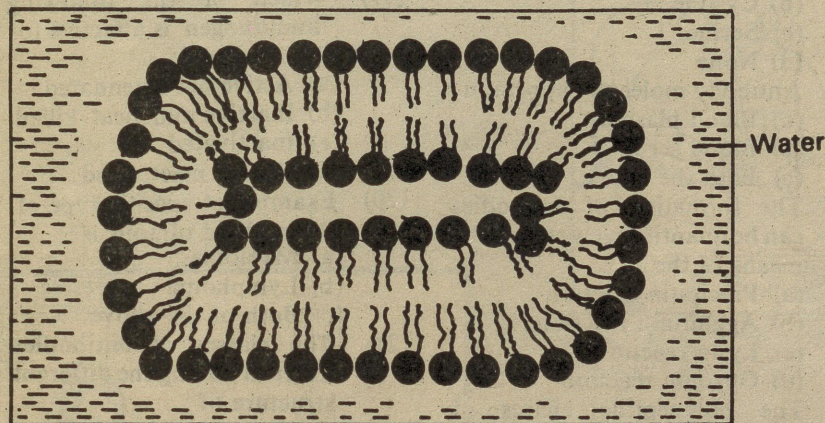


Fig. 4

has been generated in biological membranes, the structural backbone of which is a double layer of phospholipid molecules, usually called "lipid bilayer". Phospholipids are molecules which have a water-permeable polar head and a water-insoluble nonpolar tail. In an aqueous medium, these lipids spontaneously disperse themselves with their hydrophilic heads towards water, the hydrophobic tails remaining away from the water. Such an aggregation leads to the formation of micelles (Fig. 1), monolayer (Fig. 2), and bilayers (Fig. 3). When an aqueous suspension of phospholipid is agitated at high frequencies, closed vesicles surrounded by a continuous lipid bilayer are formed which are known as liposomes (Fig. 4).

Phospholipid bilayers and liposomes have been extensively studied because of their properties being very close to those of natural membranes which are very thin films—thinner than even the walls of a soap bubble. They constitute a protecting layer around a cell, the smallest unit of a living organism, and separate it from the environment. Also, they provide the intracellular partitions. It should

be mentioned that membranes are not simply inert skins holding the cells together but their function is quite complex. They contain enzymes, some acting on substrates outside the membrane and others on substrates enclosed within compart-

ments. The surface of cell membranes contains specific patches acting as recognition sites with the distinctive function of receiving certain molecular signals. For example, the membranes of some bacteria can feel a small difference in the concentration of a nutrient, stimulating them to swim towards the source of the nutrient, a phenomenon called chemotaxis.

In a normally functioning cell, the lipid bilayer is not permeable to ions and molecules of water-soluble substances, but it has a transport system which exercises selectivity. An impairment of the solid phospholipid bilayer disturbs permeability of the membrane, thereby accelerating cell atrophy which has a deleterious effect on the organism as a whole.

Working on the problems of cell's death, Yu. Vladimirov and his group from the Institute of Physicochemical Medicine, USSR, showed that oxygen deficiency, known as hypoxia, arrested pumping out of calcium ions from the cell which, in turn, activated cell damaging enzymes like phospholipases. The density of the lipid bilayer was impaired due to the cleavage of phos-

**Science quiz
(immunology)**

- (1) The molecules of which of the following immunity are collectively called as Ig:
 (a) Humoral Immunity
 (b) Cellular Immunity
 (c) Both the above
- (2) The antigen-antibody binding involves all of the following except:
 (a) Hydrophobic forces
 (b) Ionic forces
 (c) Van der Waals' forces
 (d) Covalent forces
- (3) The binding site—'determinant' is present on the:
 (a) Antigen
 (b) Antibody
 (c) Both the above
- (4) An antibody molecule is:
 (a) Monovalent
 (b) Bivalent
 (c) Trivalent
 (d) Tetravalent
- (5) The antigen-antibody reaction is:
 (a) Reversible
 (b) Irreversible
 (c) Both the above
- (6) The cells which never secrete antibodies are:
 (a) B-lymphocytes or B-Cells
 (b) T-lymphocytes or T-Cells
 (c) Both the above
- (7) The initial class of antibodies, which is synthesized in an animal's body against the antigen, is:
 (a) Ig M
 (b) Ig D
 (c) Ig G
 (d) Ig A
- (8) Which of the following class of antibodies can pass through the placenta to the fetus:
 (a) Ig M
 (b) Ig D
 (c) Ig G
 (d) Ig E
- (9) Which of the following plays an important role in the structure of immunoglobulins:
 (a) Cysteine
 (b) Cystine
 (c) Serine
 (d) None
- (10) Antibody molecules appear in:
 (a) Blood plasma
 (b) Blood serum
 (c) Both the above
- (11) The formation of antibodies can be quantitatively studied by means of the:
 (a) Precipitin reaction
 (b) Agglutinin reaction
 (c) Lysin reaction
 (d) Opsonin reaction
- (12) The polypeptide chains of antibodies have:
 (a) Intrachain disulfide cross-linkages
 (b) Interchain disulfide cross-linkages
 (c) Both the above.
- (13) The DNA for 'Variable' regions is made from:
 (a) V and D genes
 (b) D and J genes
 (c) V and J genes
 (d) V, D and J genes
- (14) An antibody molecule has how many antigen binding sites:
 (a) One
 (b) Two
 (c) Four
- (15) To increase the production of antibodies, i.e., in the process of 'Cooperation':
 (a) T-Cells stimulate B-Cells
 (b) B-Cells stimulate T-Cells
 (c) Both the above processes take place
- (16) T-Cells and B-Cells can be distinguished by:
 (a) Light microscopy
 (b) Fluorescent microscopy
 (c) TEM
 (d) SEM
- (17) Antigens having 'specificity' as well as 'immunogenicity' are called:
 (a) Complete antigens
 (b) Incomplete antigens
 (c) Partial antigens
- (18) Neutralizing antibodies indicate the presence of certain:
 (a) Viruses
 (b) Bacteria
 (c) Protozoa
 (d) None of the above
- (19) Which of the following 'Immunogen' is affective for "Small Pox":
 (a) Active but attenuated
 (b) Inactive and heat killed
 (c) Inactivated
 (d) Phenol inactivated
- (20) Example of specific type of B-lymphoid tumour is:
 (a) Myeloma
 (b) Lymphoma
 (c) Both of the above
- (21) The classes of antibodies differ in having the different structure of:
 (a) Heavy chain
 (b) Light chain
 (c) In both of the above chains
- (22) The immunoglobulin synthesis takes place in which of the following organelle of the B-Cells:
 (a) R.E.R. membranes
 (b) S.E.R. membranes
 (c) Golgi complex
 (d) None of the above organelles.
- (23) The signal sequence is absent in:
 (a) Mature antibodies
 (b) Immature antibodies
 (c) In both the above
- (24) In important factor secreted by macrophage, called "Interleukin-1" or IL-1, is required for activation of:
 (a) B-Cells
 (b) T-Cells
 (c) TH-Cells
 (d) All of the above Cells

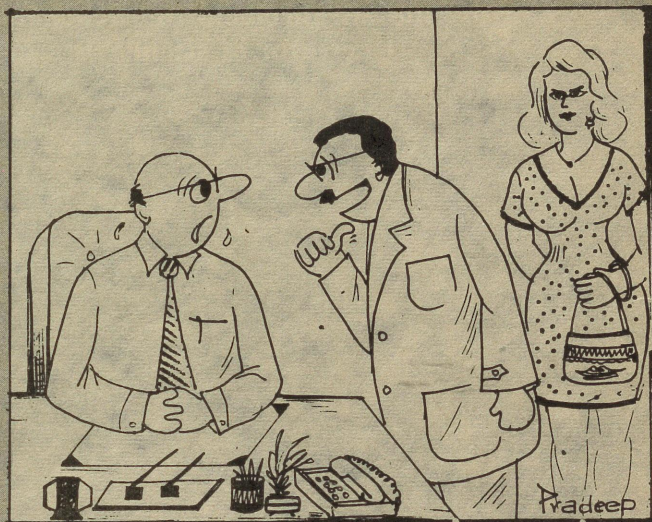
Arun Kumar Tewari
School of life Sciences
Jawaharlal Nehru University
New Delhi-110 067

Answers to science quiz:

- (1) a, (2) d, (3) a, (4) b, (5) a, (6) b, (7) a, (8) c, (9) b, (10) b, (11) a, (12) c, (13) d, (14) b, (15) a, (16) d, (17) a, (18) a, (19) a, (20) a, (21) a, (22) a, (23) a, (24) a,

CARTOONS

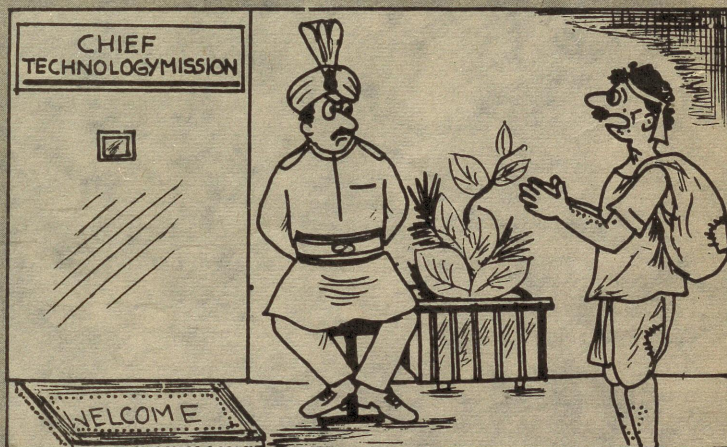
By Pradeep K. Srivastava



"She is here, Sir! Remember, you wanted a suitable "model" for biological screening"



"It's good that you are a Ph.D. in theoretical physics, but remember in life, "Be Practical"."



"No, No, I am happy about the progress made by various technology missions. I have come to ask : can't he appoint a technology mission on just POOR only?"



"No use showing me this report, Sir. If you are against the use of plastic spoons go and complain to the Manager or Director"

How the advancement of science has humbled man, the very creator of science, is a fascinating story

THE UNIVERSE THROUGH AGES

V. VENKATESWARA RAO

SCIENCE REPORTER SEPTEMBER 1989

A man said to Universe
'Sir, I exist.'
'However,' replied Universe,
'The fact has not created in me
A sense of obligation.'

—Stephen Crane

FROM the very beginning of civilization man's innate qualities like curiosity and inquisitiveness have made him to observe and analyse his natural surroundings. The aim of such studies was to unearth the secrets of nature and to understand the relation between man and nature. He formulated hypotheses on the basis of observations and this kind of thought process went on for centuries. Later, from the time of Galileo onwards, science—which earlier was called natural philosophy—acquired solid foundation with the introduction of experimental confirmation for every thesis and intuitive idea. With the participation of more and more peo-

ple in the cultivation of science, its growth now has become exponential. But, paradoxically, each progressive step made in the development of science has diminished the stature and significance of man in the universe, once man being its central figure. How the advancement of science has humbled man, the very creator of science, is a fascinating story.

Man versus the Universe

Our planet, the earth, forms part of the solar system. The solar system consists of the sun, the planets and their satellites, the moons. The earth is about 150 million km away from the sun. The farthest planet, Pluto, is about 6000 million km from the sun. Travelling at a speed of about 300,000 km per second light covers the sun-earth distance in a little over eight minutes and the sun-Pluto distance is nearly five and a half hours.

A huge cluster of stars is called a galaxy; the one of which our solar system forms a part is named the

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Milky Way. It is bun-like in shape with a diameter of 100,000 light years (Fig. 3). It has more than 100,000 million stars of which the sun is only a minor one. The present estimate is that there are at least 10,000 million galaxies in the universe and that they are not stationary, but always receding away one from the other. With the presently available telescopes we can see galaxies whose light has taken roughly 1000 million years to reach us. Further development of telescopes may take our view deeper into the universe. These features of the universe amply illustrate its unimaginable vastness.

On the basis of explorations made by cosmologists, it is now estimated that the universe was created about 15,000 million years ago. Indications are that the sun and planets were formed about 4500 million years ago. Man-like creatures have been on earth for only 3 to 4 million years. Thus man has been in existence on our planet for less than one thousandth of the age of the earth.

Coming to the stature of the sun in our galaxy, it is at a distance of 30,000 light-years (light year = 9×10^{12} km) away from the centre of the Milky Way galaxy (also known as the Galaxy, with a capital G) and thus it is in no way occupying a privileged position. The time scales are very long. The sun takes as long as 200 million years to complete one orbit round the centre of the Galaxy, whereas the earth takes only one year to make one revolution around the sun.

Now let us consider the masses of various bodies. The earth has a mass of approximately 6 million million million (6×10^{24}) kg. The mass of the sun is 100,000 times that of the earth. Our Galaxy is about 100 million times as massive as the sun. The amount of matter estimated in the observable universe is at least 300 million million million (3×10^{20}) times the solar mass. In comparison an adult human has a mass ranging from a mere 50 to 100 kg.

The primitive model

If we go back 2500 years, that is, to 600 B.C., then the entire universe known to man was a patch of flat ground, that too not a very large

patch. For our forefathers the universe was a small flat ground and the sky overhead with small luminous objects shining in it. The sky did not seem to be very far above.

The Assyrian Empire before 600 B.C. extended from Egypt to Babylonia stretching 2400 km. This empire was replaced around 600 B.C. by the Persian Empire which extended from Cyranaca to Kashmir a distance of over 5000 km. Perhaps soldiers and travellers had scanned these long stretches and had some concept of the vastness of these empires. But the common folk were content to live and die on their few acres, or tra-

velled occasionally from their village to a neighbouring one.

All men, before the time of the Greeks considered the earth to be flat. This concept created a problem: If the earth were really flat, an edge of some sort seemed to be inevitable. If the earth had an edge or boundary, naturally people would fall off if they reached that end. The solution thought of was that the dry land was surrounded by ocean on all sides preventing the people from falling off. However, this suggestion raised another puzzle to be sorted out. What was to protect the ocean from pouring off the ends and draining away from the earth?

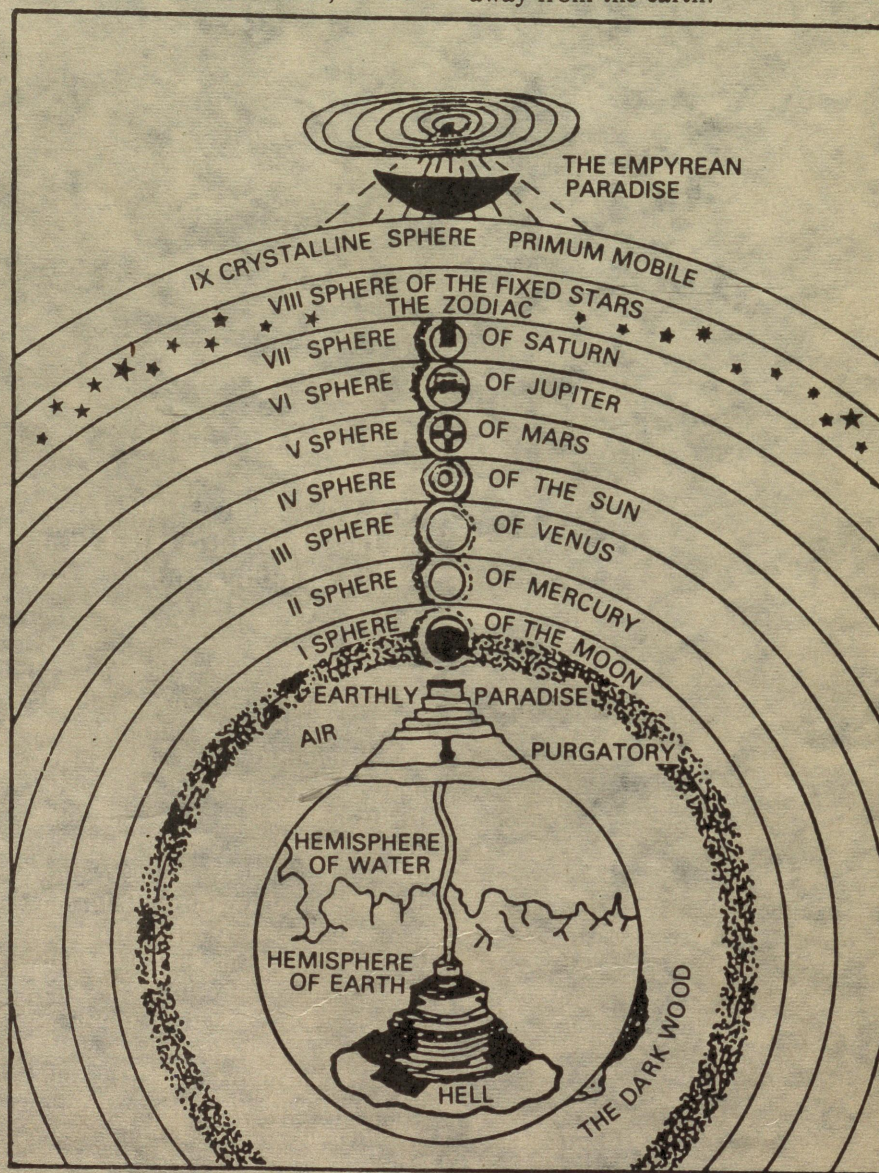


Fig. 1. Medieval universe presented by Dante in the 'Divine Comedy'



Tycho Brahe

A simple solution for this dilemma was to assume that the sky was a solid shield joined to earth on all sides. In this way the universe was thought to consist of a sort of box or closed chamber. With the sky providing the curved top and sides, the ocean and dryland being the flat bottom. This model explains well why moving things and water do not fall off. The Greeks tended to think of the earth as a circular slab of the 'Box Universe' with Greece at the centre.

Later the Greek astronomers realized that the shape of the earth is spherical because during an eclipse of the moon the earth's shadow is round. They guessed that the shadow with circular cross-section in all directions was possible if and only if the earth was spherical in shape. From the ground the earth appears flat because it is such a large sphere that the small portion of it which is visually observable has a curvature too small to be detectable. The concept of a spherical earth automatically eliminated the problem of an 'edge' of the earth because a sphere has a finite size without an edge.

It may not be out of place to note the concept of Hindus who believed that the flat earth was standing on four pillars. The pillars were supported by elephants, which in turn stood on a gigantic turtle. Who held the turtle? It floated on a big ocean. Then who supported the ocean? To continue the chain further posed difficulties of the most serious sort, even philosophically speaking.

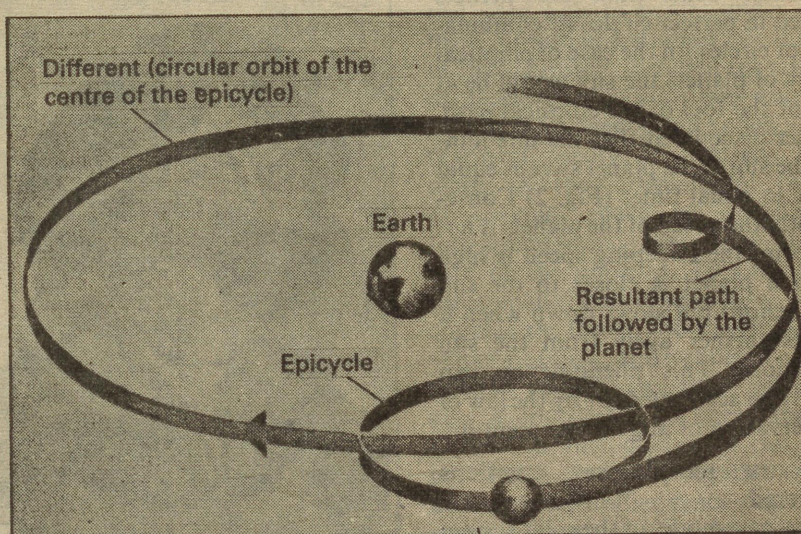
The medieval model

The medieval model of the universe described by Dante in the 13th century included everything that was known by then. Dante's depiction was based on the reconciliation of Christian theology with Greek science. Following Aristotle and Ptolemy, the spherical and stationary earth was located at the centre. Nine transparent and revolving spheres surrounded the earth as illustrated in Fig. 1. Eight of these spheres carried the sun, the moon, five planets (wanderers) and the fixed stars. The ninth one called *Primum mobile*

usually it faded out due to the advancement of science.

The heliocentric model—a leap forward

The first major attack on the medieval model was initiated by a canon of Roman Church, Nicholas Copernicus in 1543. The Copernican revolutionary development was to replace the earth from the centre of the universe by the sun, thereby giving birth to the heliocentric model. Copernicus accepted the medieval doctrine that the celestial bodies must move in perfect circles at uni-



The concept of "epicycles" was introduced to explain the movement of planets in the night sky monitored everything around. Above the ninth sphere was the tenth Heaven, different from the earthly paradise.

This medieval model distinguished between the nature of terrestrial and celestial things. Everything underneath the moon was considered to be made up of the four elements of mundane matter—earth, water, air and fire. But things above the moon were thought to be composed of a more perfect type of matter, a fifth element called aether. According to the medieval model the nine celestial spheres carrying everything we see in the sky, revolved around the earth, each one of them at its own speed.

The medieval model of the universe worked successfully for several centuries and answered a number of questions about the origin, structure and purpose of the world. But even-

form speed. The idea of the cosmos with the sun at the centre was, however, not entirely new. It had been put forward notably by Aristarchos of Samos in the 3rd century B.C. But Copernicus could show mathematically that such a model would work and it was simpler than that of Ptolemy.

The rigid notion of the unchanging nature of celestial bodies was demolished by the great observational astronomer, Tycho Brahe. Through his meticulous observations, he noticed the sudden appearance of a bright star in the constellation of Cassiopeia in 1572. For a short while this star (now known to be a supernova) shone as brightly as Venus and disappeared by the year 1574. Furthermore, Tycho Brahe showed that the great comet of 1577 was at least three times as far away as the moon

from earth, well inside the unchanging Heavens. It is a well known fact that comets change and decay. These two discoveries proved that there was something wrong with the idea that celestial bodies never change. One more embarrassing question was: How could a comet travel through the solid transparent spheres?

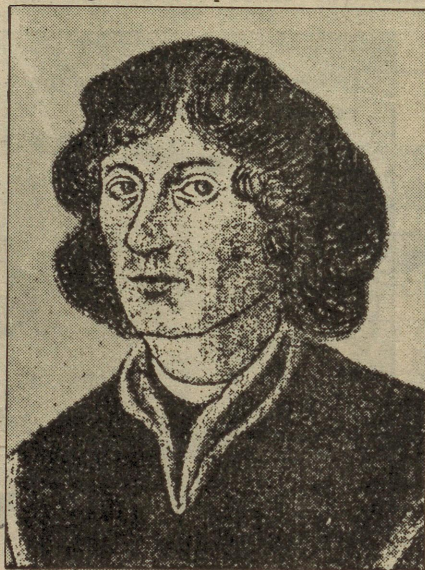
The great German mathematician, Johannes Kepler, by analysing the comprehensive and accurate observations of Mars recorded by Tycho Brahe, showed that the orbits of planets were ellipses. The idea of elliptical orbits was contrary to the orthodox belief that the planets moved in perfect circles or combination of circles. In the case of elliptical orbits of planets the sun would be at one of the foci of the elliptical path. Kepler discovered that the line joining the sun and a planet sweeps equal areas in equal times (Fig. 2) Consequently the speed of the planets is not uniform; the sweeping speed is high when a planet is closer to the sun (perihelion) but slows down when it moves farther away from the sun (aphelion). This phenomenon can clearly be accounted for by the law of conservation of angular momentum.

The new model: key questions answered

Any new model of the solar system would be accepted provided three fundamental questions about the motion of planets could be convincingly answered. First of all, if the planets are not carried round the earth by transparent spheres driven by the dispensation of God, then what makes them move? Secondly, if they are not guided by Angels, what holds them in their orbits? Thirdly, as suggested by Aristotle, heavy bodies fall to the earth seeking their proper place. How can we explain their behaviour if the earth was itself moving?

During the 17th century many scientists provided the necessary information to answer these questions. Notable among them were Galileo, Rene Descartes and Robert Hooke. Galileo proposed accelerated motion, supposedly after experimenting with falling bodies dropped from the leaning tower of Pisa. Des-

cartes came up with the idea that a body moves in a straight line until it collides with another body, the basis for the principle of inertia. Hooke suggested that there must be a force of attraction between all bodies which holds the planets in their orbits and also causes bodies to fall on earth. But nobody could estimate how powerful this force on the planets would have to be and how it varied with distance to make the planets move in ellipses. Hooke's proposal was a seed sown for the gravitational law. The burden of weaving all these pieces of informa-



Nicolaus Copernicus

tion together and formulating the laws concerned fell on the shoulders of an intellectual giant, Isaac Newton.

Newton answered mathematically and with the power of reasons all the three key questions posed above. He showed that the motions of the things we observe in the sky, say stars, the sun, moon, planets and comets could be explained by three laws of motion together with the law of universal gravitation. He further showed that all the motions that we see on earth, all things from ocean tides to the behaviour of projectiles and falling apples, are also governed by these same laws. He demonstrated that, contrary to the view held earlier, terrestrial and celestial motions obeyed the same laws without any distinction. His law of gravitation tells us that the planets and the moon are held in their orbits by the force of gravity.

By the end of the 18th century, the medieval model of the universe was completely overthrown and the Newtonian system of the world took firm roots. During the years that followed the publication of the *Principia*, mathematical astronomers put Newton's laws of motion to the most stringent tests by solving a variety of difficult questions concerning the motions of Jupiter, Saturn and the moon. It was firmly established that

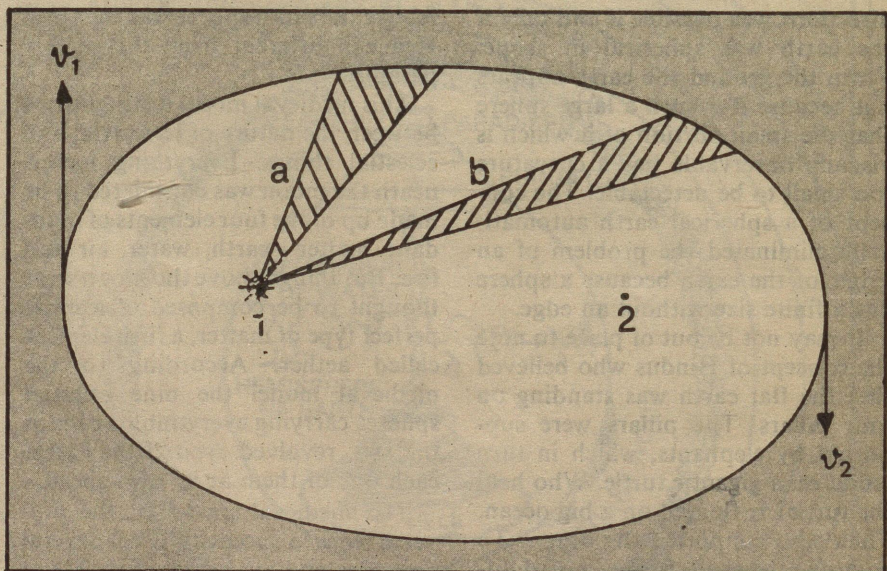


Fig. 2. The planets covering equal area of segments (a and b) in equal intervals in elliptical orbits. V_1 and V_2 are velocities of planet at extreme positions.



Galileo Galilei

dynamics was the leading model of human knowledge.

The scientific knowledge which we now call 'classical physics', covering dynamics, thermodynamics and electromagnetism, was impressive and explained many physical phenomena. Naturally many people thought that there was not much more to be done. In 1902, America's first Nobel Laureate, Albert Michelson is reported to have said "the more important fundamental laws and facts of physical science have all been discovered and these are now so firmly established that the possibility of their ever being supplanted in consequence of new discoveries is remote". Of course, he was absolutely wrong.

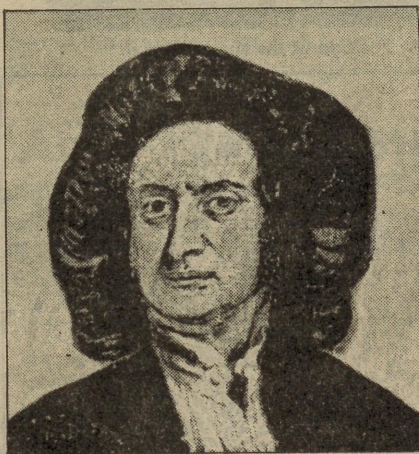
New understanding of space and time

Newton wrote in his *System of the World* that "Absolute space exists without relation to anything external, it remains always similar and immovable; absolute time flows equally without relation to anything external." These and other classical and commonsense ideas were put to severe test with the advent of Einstein's special theory of relativity in 1905.

There are a great number of peculiar effects predicted by the special theory of relativity. The first and foremost was to throw out Newton's solid framework of absolute time and space. According to the new theory,

time is reckoned with an event and an event-independent time does not exist. In the absence of an event there is no need for time. Time interval is the time lapsed between two events. For example, your birth is an event and your age is counted from that event. Similarly, space has no relevance unless matter exists.

Classical theory puts no limit for the velocity with which a body moves. If sufficient force is applied there is no bar for a body to attain infinite velocity. But the theory of relativity tells us that no material body can reach the velocity of light which is said to be the limiting value in velocities. Further, it said, measurements are relative and depend on the relative velocity between the



Isaac Newton

measurer and the object under measurement. Fast-moving clocks go slow with increase of velocity. Besides, faster the velocity of a body greater will be its mass and shorter will be its length in the direction of motion. Mass-energy equivalence was established by the celebrated formula $E=mc^2$. It was shown that the increase in the mass of a moving body is exactly proportional to the increase in its kinetic energy, and that gain in mass and gain in energy are indistinguishable.

These relativistic effects are appreciable only at velocities that are a significant fraction of the velocity of light. At speeds we commonly experience in everyday life these effects are negligible and not discernible. But they are of utmost importance at speeds we encounter in

particle accelerators, cosmic ray studies, nuclear engineering and in all physical processes where high velocities are involved. A clock travelling at 260,000 km per second shows only half the time shown by a clock relatively at rest. Similarly, if a rod of length of 100 m is moving with the speed mentioned above in the direction of its length, a stationary observer finds its length to be only 50m. Naturally, these uncommon findings are quite contrary to our commonsense experience.

The special theory of relativity is restricted only to bodies under uniform motion in a straight line. Later in 1916, Einstein included the effects of accelerated motion and gravitation into his theory and called it the "General theory of relativity." In place of the conventional three-dimensional space he introduced four-dimensional space-time structure of the universe. To the usual three spatial coordinates x, y, z he coupled the fourth coordinate ct , (c = velocity of light, and t = time) the product of velocity and time, which is also a coordinate of linear spatial dimension. Introduction of this new coordinate converted separate space and time into unified space-time. The general theory of relativity made us understand how space, time, mass, inertia, gravitation, the paths of light rays and many other things are related in the space-time structure. It explained a number of celestial phenomena that involve very high energies, strong gravitational fields and very large distances. Space curvature is an important idea introduced to explain the motion of celestial bodies.

Space curvature could be illustrated by means of a simple experiment that students perform in elementary physics. Spread iron filings on a stiff sheet of paper held above a bar magnet. When you shake the iron filings they align themselves in a particular pattern as shown in Fig. 4. This pattern is nothing but the magnetic field produced by the magnet. When you move a magnetic needle in this field, it follows the paths of the magnetic lines of force. In a similar way, Einstein concluded

that stars, moons and other celestial bodies individually determine the properties of space around them causing curved paths. This is known as curvature of space caused by the matter present in a particular region of space. Just as the movement of a piece of iron in a magnetic field is guided by the structure of the field, the path of any object in a gravita-

tion field is determined by the geometry of that field. The structure of the curved space produced by the sun guides the planets. Thus, according to relativity theory, mass does not produce gravitation, but curvature of space explains the motion of celestial bodies. So, general relativity replaced gravitation by curvature of space.

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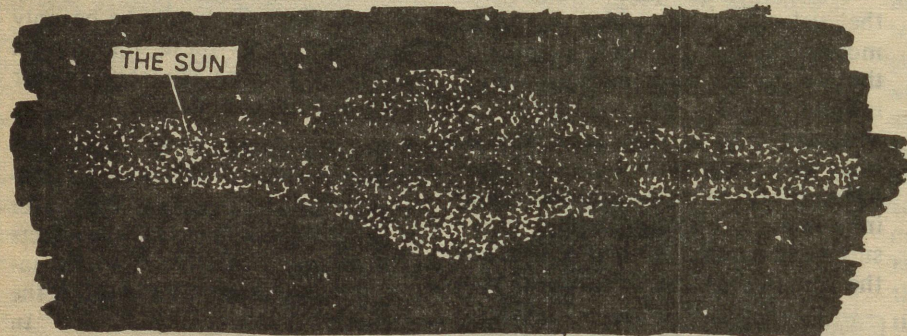


Fig. 3. The shape of the Milky Way. Position of the sun is marked

With the discovery of newer and giant accelerators of enormous energy have come up in various countries to probe into the nucleus. This race has resulted in the discovery of about 200 subatomic particles. In contrast, when Bohr announced his model of the atom in 1913, only 2 subatomic particles—electron and proton—were known.

The realm of the atomic and subatomic world

In the microworld on the other end, the atom visualized as a solid particle like billiard balls had served extremely well in the 19th century. But it could not explain the dramatic discoveries like J.J. Thomson's electron, Henri Becquerel's radioactivity and Konrad Rontgen's X-rays, made during the last decade of the 19th century.

In early years of the 20th century a simple planetary model of the atom was conceived. The next stage was to break the nucleus and look into it. In 1919, Ernest Rutherford split the nucleus of nitrogen by hitting it with an alpha particle emitted by natural radioactivity. Later it was realised that fast moving particles of high energy were needed to have a good insight into the atomic nucleus. The first particle accelerator was designed and built by J.D. Cockroft and E.T.S. Walton in 1931. From then on

newer particles, the picture of the structure of matter has become utterly confusing. It was proposed in 1963 that the so called fundamental particles like proton and neutron are no more fundamental, but are combinations of a small family of more fundamental particles called quarks. To start with it was believed that three kinds of quarks were enough to understand the structure of any particle. Subsequently, the quark population has grown and now there

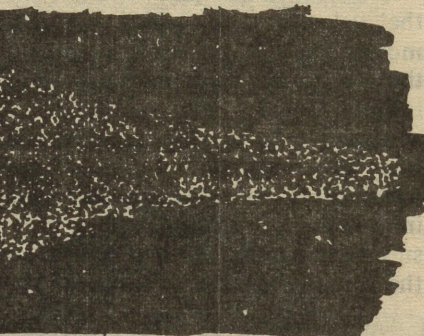


Fig. 4. The structure of magnetic field around the bar magnet

appears to be 18 quarks and 18 anti-quarks. No one yet knows where the search for particles will lead to.

The life on earth and extra-terrestrial intelligence

The life on earth and extra-terrestrial intelligence

19th century science had established that cells were the basic building blocks of living matter. The scientific study of the cell, called cytology, was initiated. By the turn of the last century a great deal was known about the structure and functions of various cells. Today the study of life science has reached the molecular level and has become more complicated. In spite of many theories we have yet to know how life appeared on earth. At present the main task is to explain the formation of the self-replicating nucleic acid molecules—the basic components of life. How and when were they formed? Various theories have been proposed, but none is fully satisfactory.

Inconclusive conclusion

We have observed how a small flat-bottomed box-like universe has turned into a vast expanse of space with billions of galaxies moving away from each other at great speed. Man and the earth, once central to the world have become unimaginably insignificant in size and weight in the vastness of the known universe. It is now realised that even life on earth may not be unique; life forms may have appeared in planets of other stars also.

In fact our scientific picture of the complex and mysterious universe would always appear to be inconclusive and provisional. With the availability of more and more sophisticated tools new data will emerge, changing our concept of the universe. The scientific 'faith' of man is that the universe is made in such a way that it can be understood by the human mind. To what extent is this 'faith' well founded is again a major question.

In the macrocosm the distances, masses and velocities of the bodies that adorn the firmament are so vast that they surpass the comprehension of the ordinary human mind. Sim-

(Continued on p. 414)

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In the world of BASIC—I

So you are also one of those who are eager to learn about computers. Perhaps, you have come across advertisements which tell you the great wonders a computer can do. Or you may have been carried away by the claim of one of the computer schools which promise to make a computer expert out of you in just a few weeks. It is also possible that you are envious of your neighbour who has bought a small computer.

Whatever be the reason, there is nothing wrong in learning about computers. They are very useful and can perform a lot of wonderful things ranging from doing simple calculations to playing interesting games. They can perform jobs which are definable or repetitive or where the volume of storage or calculations is vast. In a fast and expanding society where time is precious they can perform myriad functions. These include rail reservations, inventory control, maintaining personal data bank etc., Similarly you can budget your expenses, play interesting games and even write your own programs. In fact, once you learn programming you may even get addicted to your computer.

Misconceptions

Before proceeding further several misconceptions about computers have to be removed from the minds of learners. Firstly, one need not know a lot of mathematics nor need one possess any academic qualification for learning about computer programming. As long as one has an analytical mind and is good at logic, programming can be learnt very fast. Secondly, one can learn it at any age. Thirdly, no matter how many courses one undergoes or how many books one reads, one can learn the art of

programming only by using a computer.

As long as correct instructions are given, a computer will never commit a mistake. And even if some wrong

instructions are given, it will politely tell you that you have goofed and point out the mistakes. And once the errors are rectified the computer will continue to proceed further. This in



As long as correct instructions are given, a computer will never commit a mistake. (Photo: Inter Nations)

turn exposes some limitations. A computer will only perform what is asked of it and not make any attempt in improving or correcting mistakes. Nor can it come up with its own solution to any problem. An intelligent person is therefore required to give specific commands for a program to work but once the program works anyone can use it.

Computer language

A computer has to be given proper

instructions. But that is not enough. To make the computer understand our instructions, we must evolve suitable ways of logic and structure so that it will translate these into its own jargon. This is called "LANGUAGE" or "SYNTAX" and a computer will understand only this language.

A computer understands a language and a program (a series of instructions) consists of writing it in terms of this language. There are several such computer languages, each designed for a particular use. Some of the important ones are BASIC, COBOL, ALGOL, FORTRAN, etc. There are differences in syntax for each one of them but the overall logic is same. Once you become familiar with one language you can easily switch over to the other.

But a language is specific and one has to be precise in writing instructions in that language. Unlike ordinary conversation, where we can afford to be vague no liberty can be taken with a computer language. A comma instead of a semicolon or the use of capital letters in place of ordinary letters can make a lot of difference. These will be dealt with later.

What is BASIC ?

In this serial one such language called BASIC will be discussed. Basic is perhaps the simplest language to learn and understand. The word BASIC is an acronym for "Beginners All Purpose Symbolic Instruction Code". It was developed in 1965 by J. Kemeny and T. Kurtz at Dartmouth College, U.S.A. It was originally developed as a conversational language. It is a simple language to learn and is also powerful. For most purposes it is adequate. The other advantage with Basic is that it can read a record from a file, process it and print the output. However, the greatest charm of Basic is that its language is both elegant and simple.

The features of Basic language can be divided into two parts: (i) Elementary or basic features, (ii) Advanced features. The latter contains additional commands but for most purposes the simple one is enough.

Throughout this serial, the elementary form will only be discussed.

There are two parts of a computer : (i) **Hardware** : These are actual devices which we can see and which make up the computer system. They include keyboard, video display unit (the screen showing display), disk drive, printer etc., Once a unit is set up, the hardware configuration remains the same or is expanded.

(ii) **Software** : These comprise the programs that tell the hardware what to do and in what manner. By changing the software, different results may be obtained to suit one's needs. Some of the softwares include BASIC, dBASE, Word Star, etc.

Personal computers and DOS Systems

A Personal Computer (PC) can be put to various applications with the help of a program. The most popular operating system created for PC is called DOS (Disc Operating System). There are several versions of this system but the one currently used is called PC DOS 3.2. Depending on the type of information processor and hardware facilities, one can have PC/AT, PC/XT etc. In this serial everything will be discussed in terms of PC/XT.

It is much easier to learn programming if one sits before a computer daily for just an hour and practices. The most ideal way to follow this, or for that matter, any computer programming, is to go through the instructions given in this serial, run the programs and then make some modifications. It would be even better if the programs can be printed and kept in a file. When you are familiar with Basic programming and you find that a new program does not work, avoid the temptation of referring to the notes immediately. Take a break and analyse the logic carefully and chances are that you will be able to locate the fault easily.

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(To be continued)

IN SEARCH OF KNOWLEDGE CSIR'S CONTRIBUTION TO SCIENCE

On the occasion of the 40th Anniversary of Independence, the Council of Scientific & Industrial Research has brought out a series of volumes *In Search of Knowledge-CSIR's Contribution to Science*. This is a selection of significant research papers in different areas of science and technology published by CSIR Scientists in national and international journals during the period 1950-83.

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Selenium as a dietary essential element was not suggested until about 1960. Today dietary selenium inadequacy is known to be associated with a wide range of disorders in animals

**IRA D. BHATTACHARYA
JOHN A. MILNER**

SELENIUM SAVES

SELENIUM is a naturally occurring trace element recognized for its unique properties intermediate between metals and nonmetals. Named after the goddess of the moon, Selene, it remained largely a chemical curiosity until the turn of the century. Its involvement in human health has been an area of considerable controversy. By the late 1930's our knowledge of selenium was limited to observations about its toxicity. It has often erroneously been referred to as the most toxic element known to mankind. By the 1950's concern about selenium exposure increased due to suggestions that this element might have carcinogenic properties (Fig. 1).

The positive image of selenium did not begin to emerge until about 1960, when it was first suggested that it might be a dietary essential nutrient. Since that time dietary selenium inadequacy has been associated with a wide range of disorders in animals. Most recently a cardiac myopathy has been described in humans consuming inadequate selenium. The continued positive image of selenium in human health has been fostered during the last 20 years by a variety of reports suggesting this trace element

has anticarcinogenic, rather than carcinogenic, properties.

Occurrence and forms

A cycle of selenium in nature has been suggested (Fig. 2). Although quantitative estimates of the transfer of selenium within each phase of the cycle are rather limited, it is clear that many factors can influence the quantity of selenium to which humans are exposed. Selenium occurs widely distributed in relatively small concentrations in rocks, soil, plants and water.

The essentiality of selenium was first suggested in the late 1950's (Schwartz and Folz, 1957), when it was shown to prevent liver necrosis in rats. Since that time, additional signs of selenium deficiency have been described in a variety of mammals. In humans, selenium deficiency causes 'Keshan disease', an endemic congestive cardiomyopathy (disorder of heart muscles) in northeast regions of China. High-risk groups are young women and children. Another selenium deficiency disease reported is the 'Keshin-Beck' disease which causes necrosis (tissue death) of cartilage, dystrophy (degeneration) of skeletal muscles and joint deformity. Selenium is unique among the essen-

tial elements in its manifestation of deficiency in the way that clinical signs are usually light, develop slowly or appear only in the second generation of animals exposed to deficiency. Interaction of selenium deficiency with additional factors, as vitamin E deficiency, excessive polyunsaturated fats in diet, presence of certain heavy metals, xenobiotics and carcinogens often result in acute, life threatening situations.

Dietary intake

The safe limits for selenium intake has been suggested as $5\mu\text{g Se/day/kg}$ body weight as oral intake, i.e., $350\mu\text{g/day}$ for a 70 kg man. In 1980, the US National Research Council proposed a safe and adequate intake of selenium from 50 to $200\mu\text{g/day}$ in adult humans. Other estimates of intake include $500\mu\text{g/day}$ in Japanese populations, who have high fish and rice diet, and upto $750\mu\text{g/day}$ in Chinese populations with no reports of toxicity. Usually $55\text{--}80\mu\text{g/day}$ is enough to maintain balance and as of present no Recommended Daily Allowance (RDA) for selenium has been recommended. Although it is present as salts or complexes with other metals, selenium rarely occurs in the elemental state. Combustion of

coal and fossil fuels, volcanic eruptions, and industries using heating procedures, such as smelting and ceramics, are often associated with the release of selenium into the atmosphere.

The selenium content of soil typically ranges between 0.1 ppm to 2.0 ppm. A portion of the selenium in soils is available to the vegetation. High-selenium soils, known as seleniferous soils, can produce plants that can cause selenium toxicity in animals. Plants can be subdivided on the basis of their ability to accumulate selenium. Soil alkalinity and aeration are also important determinants of the quantity of selenium that plants accumulate. While some plants can accumulate excessive quantities there is little evidence that naturally occurring soil selenium can cause damage to commercially important crops. Within the plant various naturally occurring selenium compounds have been isolated including selenocysteine, selenocystine, selenomethionine and dimethyl selenide.

and liver typically reflect dietary intakes. However, bioavailability of selenium does depend upon the form of selenium as well as other factors. The selenium content of some major food groups are given in Table 1.

Metabolic function of selenium

The currently known biochemical functions of selenium are as a component of the enzyme 'glutathione peroxidase' (GPx) which is found in animals and several bacterial enzyme systems. This enzyme in presence of reduced glutathione protects erythrocytes against oxidative damage. Selenium may have other biochemical functions in higher animals that are not dependent on the ability of glutathione peroxidase to serve as a biological antioxidant. Biochemical function of vitamin E seems most complimentary to that of Se. Selenium has been shown to reduce toxicity of cadmium, inorganic and methyl mercury, thallium and silver. Lead and copper are more toxic to selenium-deficient animals.

The tissue selenium content not

selenium intake.

High selenium

In industrial workers, over exposure causes garlicky breath. Loss of hair and nails are common signs of selenium poisoning. Lesions of skin and nervous system have also been observed in areas of high incidence of selenium toxicity. Acute selenium toxicity as a result of administration of sodium selenite or selenate to experimental animals such as rabbits, rats, cats has been seen with variation of 1.3mg/kg-3.0 mg/kg body weight. Inhalation of volatile methylated selenium metabolites cause vomiting, dyspnea, spasm and death from respiratory failure. Liver necrosis, hemorrhage atony (loss of elasticity/flexibility) of smooth muscles and erosion of bones.

Selenium and disease prevention

Chronic 4-5 ppm dietary selenium causes growth inhibition but this is reversed by a number of factors. Various reports from all over the world indicate that selenium deficiency is associated with different chronic

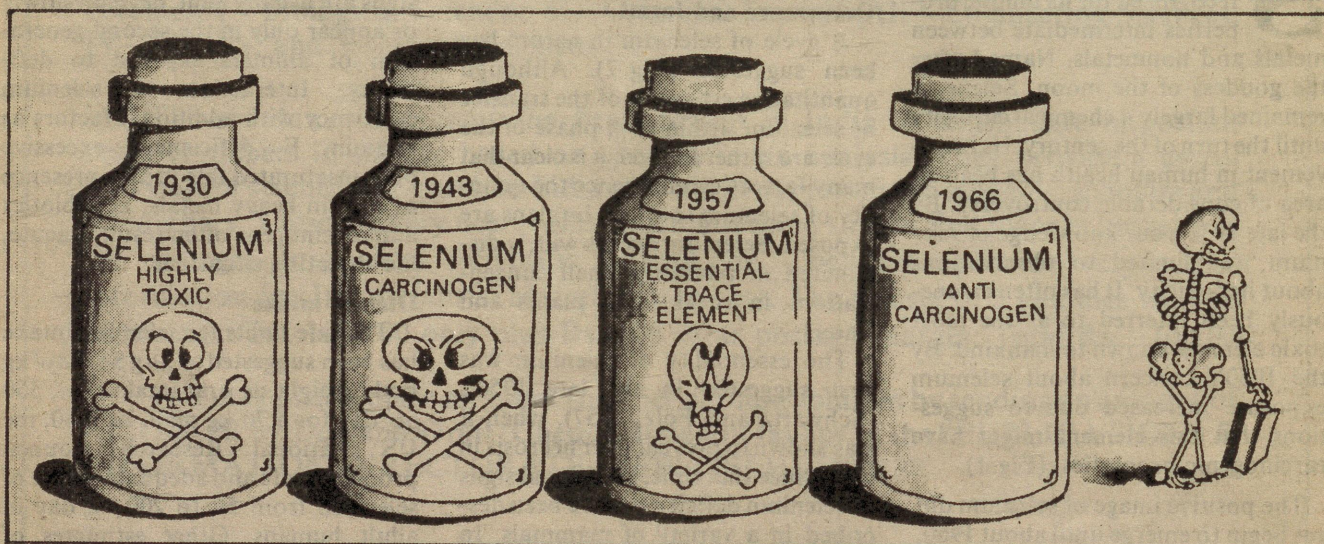


Fig. 1. The public image of selenium (From Vernie, L.N. *Biochimica et Biophysica Acta* 738 (1984), 203-217)

Selenium is efficiently transferred up the soil, plant, animal and human food chain. Geographical distribution of selenium within the soil accounts for the majority of the variation in the selenium content of the foods. The selenium content of food and feedstuffs varies with plant species and geographical area. Concentration of selenium in blood, kidneys

only depends on diet but also on the chemical form. Organic forms are deposited more in tissues than the inorganic forms. The availability from plant sources was found to be higher than that from animal sources. Many other factors influence the metabolism of selenium such as sulphur, arsenic, other metals, microbes, vitamin E, and previous

human diseases. A number of diseases induced by other toxic elements such as cadmium induced hypertension in rats, can be alleviated by selenium. Its role as an anticarcinogenic agent is well recognised, although not in all types of cancers and tumors.

Several studies have suggested that there may be a relationship between lowered selenium status and human

Table 1. Selenium content of vegetables, fruits, grains and cereal products

Product	$\mu\text{g Se/g}$
Vegetables	
Carrots, fresh	0.022
Cabbage, fresh	0.022
Cauliflower, fresh	0.006
Corn, fresh	0.004
Garlic, fresh	0.250
Green pepper, fresh	0.007
Green Beans, fresh	0.006
Lettuce, fresh	0.008
Mushrooms	
Fresh	0.130
Canned	0.109
Onions, white fresh	0.015
Potatoes	
Sweet, fresh	0.007
White, fresh	0.004
Radishes, fresh	0.040
Tomatoes, fresh	0.005
Turnips, fresh	0.007
Fruits	
Apples, fresh peeled	0.004
Apple sauce, canned	0.002
Bananas, fresh peeled	0.010
Oranges, fresh peeled	0.013
Peaches, fresh peeled	0.004
Pears	
Fresh, peeled	0.006
Canned	< 0.002
Pineapples	
Fresh	0.006
Canned	0.010
Cereals	
Barley cereal	0.659
Bread	
White	0.277
Whole wheat	0.665
Corn flakes	0.026
Flour	
White	0.192
Whole wheat	0.636
Noodles, egg	0.623
Oats, quick	0.110
Rice	
Polished	0.318
Brown	0.387
Wheat cereal	0.241
Wheat breakfast	
Cereal prepared	0.105

(From: *J. Nutr.*, 100: 1385-1386, 1970)

cardiovascular diseases. In China, selenium supplementation has been shown to reduce a primary high rate of Keshan disease in children. Selenium deficiency signs are frequently indistinguishable from vitamin E deficiency such as hepatic necrosis, edema and pancreatic dystrophy.

Based on food consumption from 17 countries, G.N. Schrauzer of Deptt. of Chemistry in University of California at San Diego (1976, 1977) concluded that mortality due to

cancer of the large intestine, and rectum was directly related to high intake of meat, egg, milk, fat, sugar and inversely proportional to high cereal and fish (high selenium) in diet. Thus selenium prevented incidence of above-mentioned cancers but increased chance of gastric and hepatic cancer.

In a study, Shamberger *et al.* at the Cleveland Clinical Foundation, Cleveland, Ohio (1975-1978) concluded that age-specific heart disease mortality was lower in those countries or parts of the world with high selenium intake than in those parts

with low intake of this element. Incidence of age specific death due to breast cancer and other cancers are also lower in areas with higher selenium intakes. However, these epidemiological data do not prove or disprove anything, they are merely suggestive.

The anticarcinogenic effects of selenium is now firmly established by numerous biological experiments. This effect usually increases with dosage applied until near-toxic levels are reached. There is also evidence that selenium deficiency in animals enhances chemical carcinogenesis

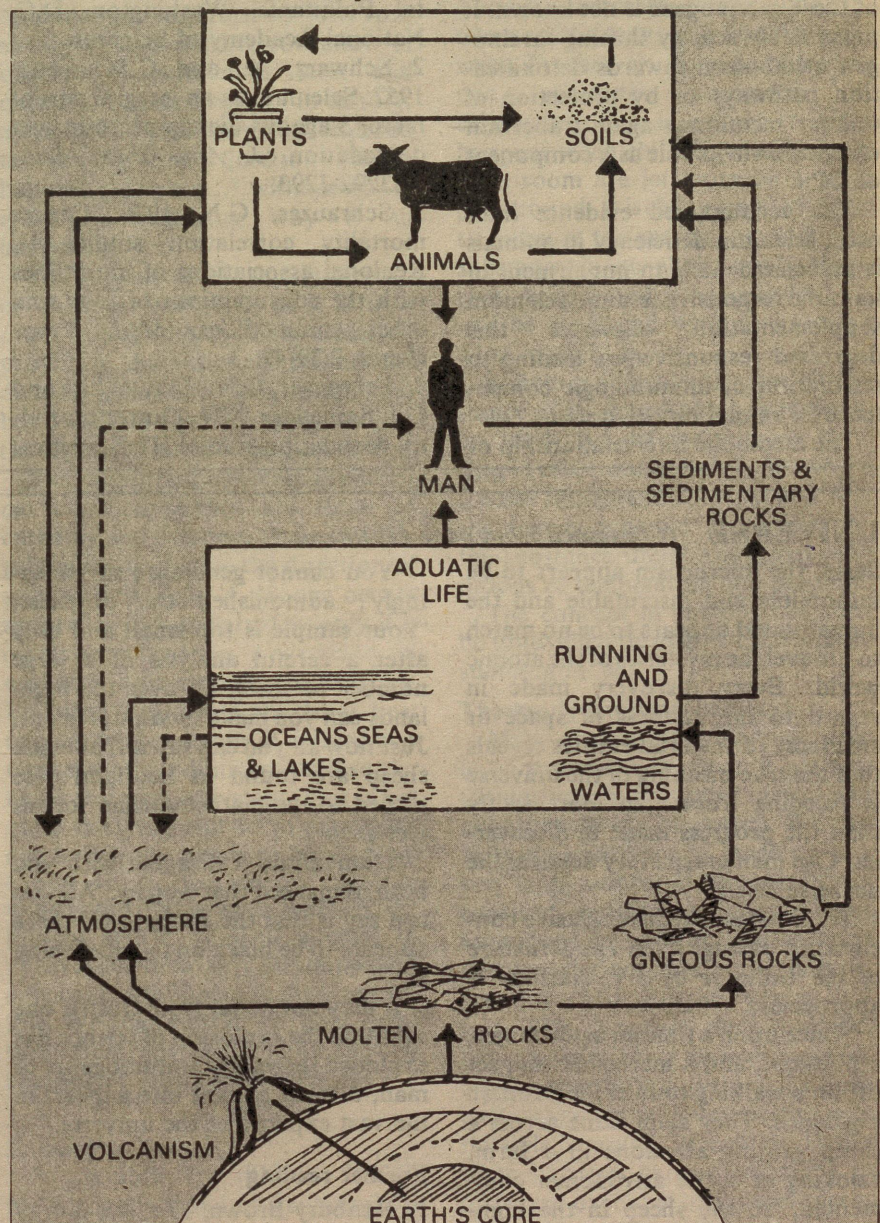


Fig. 2. Cycling of selenium in nature. From NRC, 1976b

and that nutritional levels ($0.1 \mu\text{g/g}$) in diet afford a significant degree of protection.

The vast literature on animal studies have shown that a high dietary level of selenium can provide protection against chemically induced and spontaneous (virally induced and transplantable) tumors in rats and mice and also against UV light-induced skin cancers in nude mice (a specially bred strain of mice). No other trace element holds as much promise as a preventive agent against cancer as selenium. The mechanisms by which selenium reduces potency of these carcinogens is not known. It presumably acts by shifting carcinogen metabolism towards detoxification pathways or by protection of cellular membrane against aberrant oxidation via its role as a component of GPx.

The accumulated evidence indicates selenium deficiency in animals is associated with an impairment of immune responsiveness and selenium supplementation alleviates this depressed responsiveness leading to restoration of immunologic competence in animal model systems.

The metabolic interrelationship of

GPx and vitamin E is particularly evident in deficiency diseases that can be prevented either by vitamin E or selenium. A variety of stresses in animals such as forced exercise, high dietary fat, infectious diseases etc., may increase incidence of lesions which are morphologically similar to those induced by selenium or vitamin E deficiency.

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UNIVERSE (Continued from page 406)

ilarly, the microcosm appears to be fathomless and inscrutable and the human mind appears to be no match to unravel the mysteries of the atomic world. Every discovery made in regard to the vastness of space or smallness of material entities reveals that the true meaning of the universe is receding from man more swiftly than the progress made in discoveries. Can man grasp every detail of the universe at all?

To illustrate my inconclusive conclusion a passage from *The Structure of the Universe* by J.V. Narlikar is appropriate.

"Once upon a time an astronomer, a physicist, and a mathematician set off on a walking tour in the Scottish highlands. They soon came across a sheep grazing all alone in a farm. Looking at it the astronomer commented, 'so the sheep in the highlands are black'.

'You cannot generalise so sweepingly', admonished the physicist, 'Your sample is too small and only after a careful analysis of a large number of sheep all over the highlands can you make such a statement. Just now all you can say is that black sheep are found in Scotland'. He turned to the mathematician for his views.

'I am afraid I disagree with you both' remarked that worthy. 'All you can say is that the animal over there appears to be black on the side facing us'."

It may not be far from truth if one says that the explosion of science has exploded the vanity and arrogance of man, turning a giant into a dwarf in the vast expanse of the universe.

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Entropy, disorder and unhappiness

'All happy families are alike but every unhappy family is unhappy in its own way'.

Tolstoy in 'Anna Kareneena'

THE first major landmark in the history of human civilisation was the discovery of fire, i.e., the art of converting the chemical energy locked up in a fuel like wood, into heat energy. Fire provided warmth and protection. It enabled man to cook food, win metals and forge them into tools and weapons. No wonder fire was elevated to the status of the Supreme Deity and worshipped in 'Yagnas' and fire temples.

The next important step—the conversion of heat into mechanical motion—came much later. The steam engine perfected by James Watt in 1765 provided the motive power that ran machines, pumped water, drove locomotives and propelled ships across the high seas. The machine thus replaced the slave or the workhorse and brought about the first industrial revolution. Strangely enough, although heat energy was thus harnessed for processes of production and locomotion, there was no clear understanding of the nature of heat. It was believed that heat was a material substance called the 'Caloric' which entered or left a body on heating or cooling. Here, thus, was a classical case of art or technology forging ahead and science lagging behind, or practice preceding principle.

It took another fifty years before the 'Caloric' theory was finally overthrown. Initially the work of Joule and Sadi Carnot, concerning itself mainly with the interconversion of heat energy and mechanical work, formed the subject matter of 'thermodynamics'. Its scope however widened with the contributions of Kelvin, Nernst, Clausius (who incidentally first

coined the word entropy) and Gibbs.

Thermodynamics soon evolved into fullfledged discipline embracing interconversion of different forms of energy and energy changes accompanying and guiding all physical and chemical processes in the universe.

In its early years, chemistry had remained an empirical subject, consisting of a confusing collection of observed experimental facts and chemical conversions. As in history, a student of chemistry was required to answer the question 'What happens (ed) when...?' without wondering or inquiring why it so happened.

The advent of 'thermodynamics', or chemical energetics as it is now often called, improved the situation providing the rationale behind the diverse chemical phenomena and bestowed on this colourful subject the logic and order it lacked earlier.

Two important concepts in chemical thermodynamics are those of enthalpy and entropy. These two largely guide or dictate the direction of chemical changes. A change occurs spontaneously or naturally only if it is accompanied by a decrease in enthalpy and increase of entropy. Enthalpy represents the total heat content while entropy is defined as a measure of randomness or disorder of a substance or system. This is not quite satisfying and so to many students, entropy seems to be a 'ghost' entity which they cannot 'see' or understand but always fear. IN the present article we shall attempt to unravel and demystify this important concept in as simple a manner as possible. We shall restrict our consideration to entropy content and entropy changes of pure substances only.

Entropy

At absolute zero, (0K or -273°C) the entropy content of a substance is zero (Third law of thermodynamics).

As heat is added, the entropy starts increasing. This increase is more when a given amount of heat is added to a substance at a lower temperature than when it is at a higher temperature. This is analogous to filling a vessel shaped like an inverted cone. For the same volume of liquid added, the rise in level is more when the initial level is low than when it is high. The increase in entropy is given by Q/T (calories per degree) where Q is the amount of heat added and T the temperature at which it is added. Entropy increases rather suddenly when a solid melts or a liquid evaporates. Further, the entropy of a gaseous substance increases on expansion. This is similar to what happens when children confined to a class room are let loose on a large playground. It is thus a simple matter to measure the entropy content of a substance in absolute terms. However, here we have an entity which can be measured without knowing what it really is.

Boltzmann visualised material substance at its microscopic or molecular level and defined entropy by a simple relationship $S=k \ln W$, where k is the Boltzmann constant and W is the thermodynamic probability of the substance under any given conditions of temperature and pressure.

The concept of entropy can then be unravelled through a clear understanding of W .

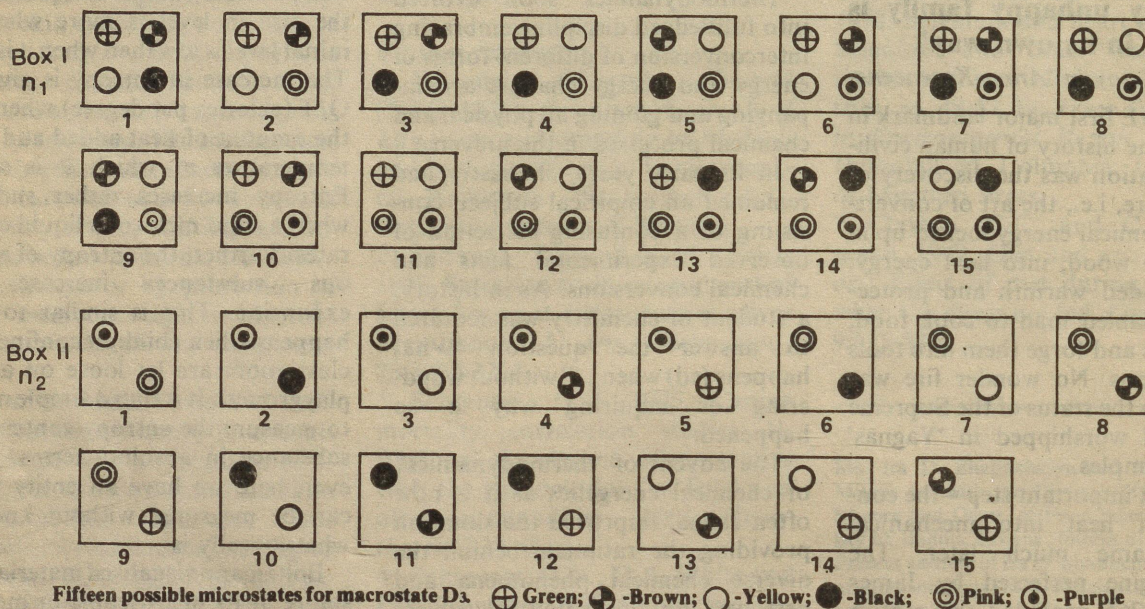
Thermodynamic probability

Most of us are familiar with two basic postulates of modern physics, the particulate nature of matter and quantum theory of energy. We can picture a substance as made up of a very large number of tiny particles in constant motion, i.e., they possess kinetic energies of vibration, rotation and translation. The particles however differ widely in their energy content. The quantum theory further tells us that their energies cannot have any arbitrary values, i.e., the particles can possess only certain permissible amounts of energy. Hence these particles can be envisaged as dispersed over a set of allowed energy levels. A certain number n_i resides in

level 1 having energy E_1 , another set of particles n_2 in level 2 having a higher energy E_2 and so on. They thus resemble a group of children sitting on successive rungs of an iron grill in a public park. Now, how are these particles a, b, c, d, etc., distributed

ments are therefore called the macrostates. This macrostate description does not tell us the exact location of each coloured ball. In the game of bridge, such a situation corresponds to saying that a player has six spades, three hearts, one diamond

ments or microstates lead to the single macrostate D_3 . The number of possible microstates within a given macrostate is called the thermodynamic probability W . This probability for any given distribution (balls in boxes or molecules among energy



among the permissible levels (of course with the proviso that their total energy content remains unchanged)? Actually there can be a large number of possible distributions. These can be understood by considering the distribution of six balls of different colours in two boxes.

The seven assignments of these six balls, D_1 , to D_7 are shown in Table 1. These seven possible arrangements however gives us only a gross picture of the distribution. These arrange-

and three clubs without specifying which particular spade or heart he holds.

Now, if for a certain macrostate, say D_3 (4, 2), we find that balls green, red, yellow and black are in box 1 then balls pink and blue are in box 2. With such a detailed knowledge we are describing just one possible arrangement of the balls—called the microstate—associated with the macrostate or gross description indicated by D_3 . It can be seen from Fig. 1 that as many as 15 different arrange-

ments) can be calculated from a simple formula

$$W = \frac{N!}{n_1! n_2! \dots}$$

where N is the total number of particles or balls and n_1, n_2 , etc., are their numbers in boxes or energy levels 1, 2... etc. (The factorial notation $4! = 4 \times 3 \times 2 \times 1$). It now turns out that D_4 ($n_1=3$ and $n_2=3$) is the one associated with the largest number of microstates. If now balls are continually poured into the two boxes, we will perceive only this macrostate D_4 which is realised through the largest number of microstates. Thus your hand in the game of Bridge also is most likely to have a distribution 4, 3, 3, 3, ($W = 2402400$), while for a combination say 7, 4, 2, 0 ($W = 25740$) has a much feebler chance. The most unlikely combination of course is 13, 0, 0, 0 ($W = 1$).

Disorder and unhappiness

One can now appreciate why disorder is more prevalent than order.

Table 1. Macrostates for the distribution of six different balls in two boxes

	D_1	D_2	D_3	D_4	D_5	D_6	D_7
n_1	6	5	4	3	2	1	0
n_2	0	1	2	3	4	5	6
w	1	6	15	20	15	6	1

Order refers to a unique preconceived arrangement of things, i.e., each thing located in its assigned place. Order, thus, can be achieved only in a single way. For example, if the scissors are in the drawer, the ball-pen on the table and the slippers on the rack, any variation of this fixed arrangement would constitute disorder. And there are innumerable ways of creating this disorder. All combinations like scissors on the table or rack, the ball-pen in the drawer and slippers under the table becomes disorder. Thus disorder, which can be realised in a very large number of ways, has a high probability and is the most commonly encountered situation.

In a similar vein, we can describe happiness as the realisation of a single set of preconceived goals or

desires like say, hard working assistants, smart kids, a beautiful wife, and so on *ad infinitum*. Like order it is a single set of desirables, something like having all the thirteen aces in a deal! A slight variation in the fulfilment of the desired objectives leads to unhappiness. Thus there is a large multitude of situations that result in unhappiness while there is only one for achieving happiness. Unhappiness is therefore the most universally experienced state simply because it can be achieved in so many different ways, i.e., it has a much higher probability.

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Xylitol: a sweetner with unique properties

OCCURRENCE of sugar alcohols (pentitols or hexitols) in plants is negligible as compared to glucose, fructose or sucrose. Particularly, pentitols are not as ubiquitous in nature as hexitols. For example, six carbon containing mannitol is an important constituent of brown algae, and D-sorbitol is found in apple, pear and peach. Only a few berries contain xylitol (pentitol) in milligramme quantities (Table 1).

Table 1. Amount of xylitol in some berries

Berries	Xylitol (mg/100 g)
Rowanberry	8.1
Blackcurrant	7.0
Raspberry	2.6
Cranberry	2.1

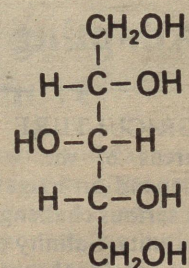
The immediate precursor in the production of xylitol is D-xylose—a pentose sugar. It is obtained in varying yields from the hydrolysis of xylose containing xylans (hemicelluloses). The agricultural waste materials such as coconut shell, corncob,

wood chips and seed hulls are rich in hemicellulosic materials. These materials can be hydrolysed using 1% H₂SO₄ at 100°C-130°C to obtain pentoses containing hydrolysate. Such a hydrolysate contains undesirable products such as formic acid, acetic acid and furfural. Hydrolysis of hemicelluloses with microbial hemicellulases (endoxyanases, exoxyanases and xylosidases) is somewhat costly but undesirable products are less and the hydrolysis can be carried out at lower temperature. Thus, pentose sugars can be obtained from lignocellulosic biomass relatively easily and in better yields than hexose sugars. Further, xylitol is manufactured by catalytic reduction of D-xylose. The hydrogenation of D-xylose to xylitol is readily accomplished at elevated temperatures (100°C-150°C) and high hydrogen pressure (50 atmosphere) by using specific metal catalysts (Raney nickel). The chemical reduction of xylitol is not cost-effective. Xylitol also can be produced as a metabolic microbial

by-product in microbial fermentation. Many yeasts and fungi possess D-xylose reductase which catalyses the reduction of D-xylose to xylitol as the first step in D-xylose metabolism. Various yeast spp. produce xylitol when grown on medium containing D-xylose as carbon and energy source. For example, a mutant strain of *Candida tropicalis* generates xylitol at greater than 90% of the theoretical yield. In contrast, the native strain of this species produces only 40% of the theoretical yield under identical conditions. Several bacterial species (*Corynebacterium*, *Enterobacter liquefaciens*) produce xylitol as a major product of pentose metabolism.

Properties

Pentitols, hexitols and shorter chain polyols are strictly not carbohydrates. They are considered along with carbohydrates because they have a similar polyhydroxyl structure and similar chemical properties. Xylitol is not commonly found in nature and therefore it is considered



as a xenobiotic sugar alcohol. Xylitol is relatively stable to the various degradative rearrangements and oxidations to which free aldo- and keto-sugars are susceptible. Its solubility in water is 68g/100 ml (25°C). It is optically inactive. The relative sweetness of a few sugars and sugar alcohols are given in Table 2. The higher level of sweetness of xylitol is in fact borne out as it surpasses sucrose and equals fructose in sweetness at low concentrations.

Applications

The polyols are not metabolised

Table 2. Relative sweetness of sugar and sugar alcohols at equal weight per cent concentration

Sugar/ Polyol (1%)	Relative sweetness
Sucrose	1.4
Fructose	2.0
Maltose	0.5
Lactose	0.7
Glucose	1.0
Galactose	0.7
Sorbitol	0.7
Arabitol	0.7
Arabinose	1.0
Xylose	0.7
Xylitol	1.9

quickly by oral bacteria and thus are useful for reducing dental decay. Xylitol has an anticariogenic property which does not cause acid formation. It is therefore used in chewing gum, one such has become the largest selling gum in Finland. It has been found that a significant portion of man's caloric requirement can be provided by dietary xylitol. Xylitol, which is a normal metabolite of the liver, is converted through the pen-

tose phosphate cycle to fructose-6-phosphate. It is then oxidized to carbon dioxide and water to yield an almost identical amount of energy as is obtained from oxidation of glucose. Several clinical applications for sugar alcohols have been suggested; for example, treatment of diabetes, bile duct and liver disorders, ketonemia and pulmonary tuberculosis. It has potential use in the treatment of conditions associated with various types of glucose-6-phosphate deficiency. Also many of the polyols possess mild laxative properties and can be used in specific conditions. However, caution must be taken since short term osmotic diarrhoea has been a commonly reported effect of oral xylitol at high dosages (greater than 100g/day).

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Adapting crop plants to salinity

AGRICULTURE in large areas of the world that depend on irrigation faces a serious challenge of salinity and alkalinity. Salinity of soil and water is caused by the presence of soluble salts originating from deteriorating and dissolving rocks and concentrated by evaporation and plant transpiration. A low concentration of salts suppresses plant growth but higher concentration causes death. In arid and semi-arid regions, insufficient precipitation results in extensive reliance on irrigation and concentration of (mainly sodium) salts in soil and water supplies which is high enough to impair the growth of plants. High salt concentrations in the soil solution create high osmotic pressure, reducing the availability of soil water to the plants. Also, the specific ions such as sodium and chloride

may prove toxic at higher concentration.

The salinity problem is most widespread, severe and threatening in arid and semi-arid lands. Estimates of saline soils range from nearly 400×10^6 to 950×10^6 hectares in the world and about 10 million hectares in India. The problem is increasing day by day and demands contemporary and innovative approaches. In recent years, several organisations in India and abroad are engaged in developing and applying new methods and equipment for irrigation management in areas having salinity and waterlogging problems. To meet the threat posed by progressive salt build-up in the soil, large schemes of reclamation and drainage are being operated through good quality water often procured from long distances. The cost

incurred is very high in terms of money, energy and water. Therefore, the engineering approach followed to manipulate environment to benefit plants is to be either substituted or supplemented by salt-tolerant genotypes to improve agricultural production in saline regions in a more economic way. Moreover, engineering schemes can not eliminate salt from saline environments; they can only minimize it. The science of genetics offers possibility of developing salt tolerant crops which, in conjunction with environmental manipulation, will improve agricultural production in saline regions on sustained basis with low input cost.

Until recently, land, water and energy were so abundant that there was little need to develop salt-tolerant crops in agriculture. But in past two or three decades the need has been felt and the genetic approaches to salinity problem have slowly gained ground. There is a great variation for salinity tolerance in the plant kingdom. Halophytes—the salt-loving plants—live and reproduce in oceans, seashores, estuaries, deltas, salt marshes and saline desert soils. They provide evidence that plant life can flourish under highly saline conditions. Some cultivated crops like beet root and date palm have also halophytic characteristics. The salt-tolerance status of many field crops, vegetable crops and horticultural crops has been studied. Among field crops barley, sugarcane, rape and cotton are considered as salt-tolerant. Asparagus and spinach are considered highly salt-tolerant vegetable crops.

There is a great need to study the variability available for salinity tolerance in these crops and then to improve upon the salt-tolerant types for their yield potential and quality traits. The research related to salt tolerance and genetic manipulation through hybridization of local salt tolerant varieties with high-yielding varieties is being conducted at the Central Soil Salinity Research Institute, Karnal (Haryana). The work is being carried out on national level at this Institute through international

collaboration. In rice and wheat, improved varieties for salt affected soils have been developed. In rice, the salinity tolerance of variety CSR-1 (Damodar) has been transferred to high-yielding varieties such as Jaya and Basmati 370 through hybridization. The recombinants with salinity tolerance and good grain quality have been recovered which are doing well under saline/sodic conditions at the national level. Similarly, in wheat some lines have been developed after crossing Kharchia (local salt-tolerant wheat grown in Kharchia tehsil of Rajasthan) with high-yielding varieties such as HD 2009 and HD 1982. Through genetic approaches attempts are also being made to introduce salinity tolerance from wild, related species/genera into cultivated varieties.

A successful interspecific cross between wild tomato and commercial tomato led to production of plants which could survive upto 70% seawater. A salt-tolerant wild tomato, *Lycopersicon cheesmanii*, from the Galapagos Islands was crossed with commercial tomato line (*Lycopersicon esculentum*). Recurrent selections for salt tolerance of the hybrids combined with back cross to the domestic cultivar gave plants which survived upto 70% seawater, a level lethal to domestic cultivar. Fruit size and yield increased with each successive back-cross and the fruit had higher soluble solids, a desirable processing character. In other grain crops like barley and wheat several attempts are underway to improve their salt tolerance. *Hordeum spontaneum* is the progenitor of cultivated barley. It is possible that *H. spontaneum* may prove useful in incorporating improved salt tolerance into the cultivated barley since some of the coastal populations of *H. spontaneum* grow on sand dunes near brackish lakes in Israel. Wheat is generally acknowledged as less salt tolerant than barley but attempts are underway to improve its tolerance through hybridization with wheat grasses (*Elymus* spp. and *Agropyrum* spp.) after making desired cyto-

netic manipulations.

The exploitation of somaclonal variability through tissue culture by differentiating different cells and tissue for their salinity tolerance on the salt media and then regenerating these cells in plants has also been useful in getting some tolerant lines in some crops such as tobacco and rice. Mutation breeding, recombinant DNA techniques and somatic hybridization may be the avenues for future progress in designing genotypes adapted for saline conditions. Recombinant DNA technology has made it possible to genetically engineer microorganisms for purposes of economically and medically important substances. The current revolution in biotechnology has also led to claim that soon it shall be possible to engineer plants for agriculturally desirable traits such as drought and salt resistance. The possibility of osmotic tolerance, partly conferring salinity tolerance in microorganisms, is being viewed towards eventually controlling capacity for

osmoregulation in plant cells through recombinant DNA technique.

Further knowledge of various mechanisms which impart salt tolerance will greatly accelerate breeding and selection programs aimed at crop improvement. It is only recently that investigators have begun to examine closely related plants in a comparative way to determine the underlying mechanisms of differing tolerance so as to develop novel varieties for saline soils. These efforts solely or in complimentation with engineering techniques of ameliorating saline soils and water will help in boosting our agricultural production on marginal lands and will solve the problem of salinity in more economic way on the sustained basis.

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Immobilized tannins : effective protein remover

DURING the last two decades research on immobilisation techniques has gained momentum due to their several advantages, mainly because immobilized substances are cheaper to use and are reusable. In Japan, immobilized enzymes and microbial cells are being used in industries for continuous optical resolution of DL-amino acids and production of L-aspartic acid, L-alanine and L-malic acid. Immobilized tannins could be used to separate, purify and recover any protein from aqueous solutions. Tannins are polyphenolic compounds which bind proteins. Tannins can thus act as a ligand for immobilization for adsorbing proteins. Other protein adsorbents include charcoal, glass, alumina, clay, silica, starch, ion

exchange resins, ion exchange celluloses, etc. However, these are not specific for proteins but adsorb various other compounds as well. When these adsorbents are used, alongwith proteins other unwanted substances are also recovered. Although tannins have been shown to bind starch, cellulose, amino acids, metal ions, etc., their affinity for these compounds is extremely low. Tannins have very high affinity for proteins and therefore are regarded as specific precipitants of proteins.

Preparation of immobilized tannins

Immobilization method, type of matrix, chain length of spacer and nature of tannins play an important role in preparing a good immobilized product. In general, the insoluble matrix having amino, carboxyl or hydroxyl group is activated by cyan-

ogen bromide, epichlorohydrin or carbodiimide. Then the aminoalkyl matrix is prepared by reacting activated matrix with diaminoalkane. The diaminoalkane (generally used is diaminoethane) provides extension to the chain length of the spacer. Tannins are activated by cyanogen bromide and then coupled with aminoalkyl matrix to give immobilized tannin. Scientists in Japan used alkali treated cellulose as a matrix and epichlorohydrin as an activating agent of the matrix. Several tannins such as Chinese gallotannins, nutgalls tannins and tannins of persimmon juice have been coupled. The type of tannin does not influence the adsorption capacity of immobilized tannins.

Characteristics of immobilized tannins

Almost all kinds of proteins get adsorbed to the immobilized tannins. The factors which affect the adsorption of proteins are pH of the solution, the kinds of proteins, incubation temperature and time, protein concentration and salt concentration. Proteins like zein and wheat glutenin get poorly adsorbed even at optimum pH. Other types of protein like albumin, globulin, protamine, phosphoprotein, glycoprotein, etc., have high affinity for immobilized tannins. Sugars, amino acids, peptides, nucleic acid related compounds, organic acids and alkaloids do not get adsorbed to immobilized Chinese gallotannin, suggesting that immobilized tannin is a specific adsorbent for proteins. However, immobilized preparation adsorbs various metal ions. Iron, copper and lead ions get adsorbed to a great extent whereas chlorine, sodium and calcium ions are adsorbed to a lesser extent.

Adsorption rate is higher at higher protein concentration and at low temperature. Maximum adsorption is generally achieved in 1-3 hours. The rate of extent of adsorption decreases at higher ionic strength.

The tannin-protein complex formation involves ionic, hydrogen and hydrophobic bindings and therefore

desorption of protein from immobilized tannins takes place under specific conditions. Some of the good solvents for desorption are; 0.1M NaCl in 0.1M sodium carbonate buffer, 0.01M NaOH and 0.01M HCl. Dilute sodium hydroxide and hydrochloride solutions (0.001M) do not desorb proteins effectively. The immobilized tannin preparation can be reused after the protein is desorbed. This makes it economical.

Applications of immobilized tannins

Removal of protein from aqueous solutions. In beer, wine and fruit juice some undesired proteins are present. They grow to larger particles during storage, resulting in turbidity if not removed. This turbidity lowers the quality of beverages. The turbid material is too small to be removed by ordinary filtration. Immobilized tannins can be effectively used for removal of undesired proteins in beverages.

Immobilization of enzymes. Immobilized enzymes have a vast potential in various industrial processes. Enzymes can be immobilized by adding enzymes in solution to immobilized tannins. As strong binding forces are involved in tannin-protein complex formation, the enzymes bound to immobilized tannins remain stable during continuous operation and even at high substrate concentrations.

Recovery, separation and purification of proteins. Proteins can be effectively recovered from blood,

urine and culture broth by using immobilized tannins. The enzyme hesperiginase has been successfully recovered from the culture broth of *Aspergillus niger*. Hesperiginase enzyme is used for removing bitter component of citrus fruit juice.

Removal of iron from water. As mentioned above immobilized tannins have high affinity for metal ions, particularly iron. The adsorption rate of metal ions increases with increase in temperature. This effect is opposite to the case of protein adsorption, indicating that the mechanisms of protein and metal ion adsorption by immobilized tannins are different. The adsorption rate of metal ions also increases with increase in pH.

The presence of iron in beverages lower their quality, therefore, it is important to remove iron water used for brewing. In water iron is present in several forms and immobilized tannins have been found to remove all the forms of iron. The efficiency of immobilized tannins for removal of iron is extremely high; it adsorbs iron even in parts per billion. Recovery of iron from the immobilized tannin is almost 100% when desorbed. Thus regeneration can be carried out without loss of adsorption capacity.

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How safe are desert coolers?

IN desert coolers and humidifiers, as well as in certain types of air-conditioning systems, cooling or humidification is achieved by drawing a stream of air through a spray or cascade of water. Consequently, any pathogenic organisms present in the water may get blown into the air. There is strong evidence that humidifiers of air-

conditioning systems can be important sources of aerosols containing microorganisms that cause hypersensitivity pneumonitis (HP) and humidifier fever (HF). (See J. Lacey and P.H. Gregory, in *Contemporary Microbial Ecology*, edited by D.C. Ellwood *et al.*; Academic Press, 1980; p. 82-83). A thermophilic actinomycete often present in the air-

conditioners is said to be the cause of HP. The symptoms of HP are chills, fever, respiratory distress, and dry cough. HP was linked to air-conditioners in 1970 by Edward F. Bonaszak, a physician at the St. Louis Hospital, Milwaukee. Dr. Bonaszak and his colleagues cured four separate cases of HP by having the employers of the patients switch over from water-supply cooling to electrical refrigeration of the air. HF is caused by amoebae growing in water reservoirs of humidifiers. Its symptoms include respiratory distress.

An even more serious illness known to be associated with such air-conditioning and humidifier systems is legionnaires' disease, a form of pneumonia. The name derives from an outbreak at a convention of the American Legion in Philadelphia in 1976, in which 221 persons were afflicted of whom 34 died. The mortality rate is estimated at 15%. According to a science programme broadcast by the Voice of America (in June 1982,) the causative bacteria, *Legionella pneumophila*, have been found to grow in small bodies of water, including pools and the cooling water of air-conditioning systems. The bacteria grow well at temperatures between 20°C and 50°C, and have been isolated from

the cooling-tower water of air-conditioning plants. After they invade the victim's body, the bacteria grow inside white blood cells, thus hoodwinking the immune system. This may be the reason for the observed high mortality rates. The disease is characterised by high fever and pneumonia.

An earlier outbreak of legionellosis near the city of Brighton in the summer of 1984, which affected at least 20 persons, was traced to *Legionella* growing in the filters of "whirlpool baths" outside a hotel. (*New Scientist*, 106, 5; May 16, 1985). The bacteria were found thriving on the minute algae and organic matter that collect in the filters. The Centers for Disease Control in the USA also found that whirlpool baths were associated with another form of legionellosis called 'Pontiac Fever' that broke out in Vermont in 1983. More than 200 workers in a Russian rubber factory in the city of Armavir suffered with legionellosis in 1987. The authorities at first suspected it to be an outbreak of AIDS.

There is a strong possibility that the causative microorganisms of hypersensitivity pneumonitis, humidification fever and legionnaires' disease could be present in the water reservoirs of desert coolers, and could be disseminated into the living

rooms. Other undesirable microbes such as fungi (e.g., *Aspergillus* species) could also be present. Unfortunately, the microbial safety of desert coolers has not been investigated. Even if legionnaires' disease is caused by them, it would have escaped notice, since it usually goes undiagnosed and is dismissed as 'non-specific pneumonia'. It is unlikely that an average physician could diagnose it. This is a matter for serious concern because desert coolers are used even in the casualty wards of hospitals. In view of these facts, there is an urgent need to investigate whether desert coolers do pose health hazards. Till such time as desert coolers can be declared safe or some means are found to make them so, their use in public buildings should be restricted.

Apart from posing potential health hazards, desert coolers are useless even for lowering the temperature unless the weather is dry. The high humidity produced by them often causes discomfort to people and also promotes overgrowth of moulds. Damage may also be caused to electrical appliances and electronic and optical instruments.

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DIABETES (Contd. from page 388)

level falls, producing symptoms that may begin to appear when the concentration is about 50mg/100ml. In diabetics who are constantly hyperglycemic, the same symptoms appear at much higher levels. The symptoms include fatigue, sudden hunger, sweating, palpitation, tremor, restlessness, flushing of face, increased pulse rate, dizziness, headache and mental confusion. In children, muscular twitchings, deepening coma and convulsions frequently occur. Hypoglycemia induces secretion of adrenaline (stress hormone) and this may in turn cause increased heart beat and tremor. If the overdose of

insulin is large and corrective measures are not taken, the patient shows profuse perspiration, tremor, emotional disturbance, unconsciousness and may even collapse. The treatment of mild or moderate hypoglycemia consists of administration of sugar in any convenient form. In serious cases, the patients are given intravenous injection of dextrose or glucose. Diabetics are advised to keep a card always with them saying "I am a diabetic: give me sugar if I am found unconscious"

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By Hasan Jawaid Khan

Why bother animals?

PLEAS of animal welfare groups to develop alternative methods for testing the toxicity of chemical products intended for human use without involving animals have fallen on deaf ears so far. Unfortunately, the behaviour of a thin layer of living cells in a culture dish can never truly be representative of what happens in an animal whose cells are arranged in highly structured communities, making culture dish experiments difficult to interpret. All is not lost, however, because research underway in the pharmaceutical division of a British firm is showing encouraging results in the field of test-tube toxicity tests. It appears that damaged culture cells release enzymes into the culture medium in a manner similar to that in which damaged cells in live animal release enzymes into the blood.

Liver cells, in particular, show an increase in activity of the so-called P450 group of isoenzymes when they are subject to toxic substances. In fact, the researchers can predict with confidence the extent to which a particular chemical will affect the liver of an animal by simply looking at the activity of these enzymes. The team has developed a test procedure for a skin irritant which employs an arrangement of cancer cells derived from a mouse teratoma (a tumour-like mass in the body). Such cells possess many of the characteristics of skin cells and

when grown under the right conditions, rearrange themselves into layers, just like skin cells and manufacture many of the same types of protein. Of course, like all cancer cells, those separated in this way are able to grow indefinitely in the culture medium.

One of the many tests carried out using the new technique is that for phototoxicity. A drug or chemical which, in the absence of light, is relatively benign, can become dangerously toxic when subject to visible or ultraviolet light. Such irradiation can also initiate reactions between the chemical under test and the chemicals in the body of the test animal. The tests involved two sets of cultured cells; one derived from mouse fibroblasts, the other from human epidermal carcinoma. A non-toxic concentration of the test substance was added to the culture medium, which was then exposed to ultraviolet radiation. Cell growth in the culture was inhibited after about 13 minutes of exposure. Further tests showed that all types of chemicals which are known to be phototoxic in humans brought about a marked reduction in safe exposure time to ultraviolet radiation in both sets of culture cells. Tetracycline, a mildly phototoxic antibiotic, for example, inhibited cell growth in both cultures in about five minutes.

Fences to protect : Great Barrier Reef

DURING the past 20 years starfish have destroyed areas of the Great Barrier Reef that may take 15 years to recover. Now researchers in Australia have found that mesh fences can protect small areas of the reef from the Crown of Thorns starfish that are eating the living coral. Scientists built enclosures using different materials with various sizes of mesh, and stocked the enclosures with starfish which they then monitored every hour for five days. They found that the starfish could not squeeze through the mesh. If they climbed the fence, they dropped off the overhang because they could not grip the wire. Even when the fence had been in place for eight months and was covered with marine growth, it still kept adult starfish at bay.

Scientists have also explored the possibilities of predicting outbreaks of starfish upto three years in advance. Such predictions are based on the fact that the starfish (*Acanthaster*), like other starfish, spawn directly into water. Larvae are then at the mercy of the currents. By simulating the hydrodynamics around the reef with computer models, scientists can plot the most likely route of the larvae and where they will settle. Masses of adults spawning in one area can amass larvae in another. It takes two to three years for the starfish to mature and become a menace.

Nutrition and Mental development

IMPROPER nutrition during the first two years of life can compromise mental development of a child. Studies at the National Institute of Nutrition Hyderabad, have shown that severe nutritional deprivation during the period of brain growth can lead to permanent functional damage if not corrected. Since brain growth in humans is complete by two years of post-natal

life, the period from mid-gestation to three years is crucial from the point of view of nutrition.

Studies at the Institute examined children who had suffered from kwashiorkor at 2 to 3 years of age and had been successfully rehabilitated. They were again examined when they were 4 to 6 years old. Results showed that they performed only half as good as the control children in a battery of

intelligence tests. Nutritional rehabilitation was found to have significant effect on the development of infants. When food supplements were given to pregnant women during the last trimester and to malnourished children during the first three years, there was a marked improvement in the birth-weight of infants and development of children.

Fertilizer for mushrooms

A team of Sydney University researchers has developed a way to use the waste of milk, whey, to produce mushroom fertiliser. Whey is mainly water and contains 0.8 per cent protein and 4 per cent lactose. It is usually disposed of by dairy companies, sometimes into waterways and thus contribute to pollution. The mushroom fertiliser is made by removing the protein from the whey and then growing yeast from the lactose which remains. The yeast is then dried and mixed with the compost where the mushrooms are grown. Mushrooms grown on the supplement-enriched compost show a 30 per cent yield increase. The team of researchers was led by Dr. Yip Cho, an expert on mushrooms. Dr. Cho believes that soon a milk factory may establish a plant to treat the milk whey that remain after cheese manufacture. This would eliminate the pollution problem.

First space ride for the transputer

A transputer, which is a computer on a single chip, is to make its first trip into space. The European Space Agency (ESA) plans to use a satellite now being built at Surrey University, near London, to evaluate a computer built from a series of transputers which will enable it to do a mass of calculations simultaneously. This so-called parallel processing is a process different from that employed in a computer made of ordinary chips which does its calculations in a slower, sequential way. The transputer would have an added advantage in a satellite because of its ability to process remote sensing information more quickly than a conventional computer. An array of transputers could process and compress remote-sensing data so that the satellite would not need bulky computer memories.

Transputers are also more resistant to damage by cosmic rays than

conventional chips. Cosmic rays harm the electronics aboard satellites in two ways, one irreversible and the second reversible. Irreversible damage is caused by a gradual accumulation of charge. But transputers do not accumulate charge to the same extent as conventional chips. The tolerance of the transputer to radiation is three times as high as the original specification NASA gave for chips to be employed in the space station. The reversible damage caused by cosmic rays occurs when they flip a transistor on to off, or vice versa, thus changing a piece of information. The parallel processing computer on the University's satellite is designed in such a manner that it carries out the same calculation three times, simultaneously, and compares the answers. If cosmic rays have changed a piece of information so that one of the processors gets the answer wrong, the other two outvote the third and flip the maverick transistor back to the right position.

Faster gene cloning technique

TWO Melbourne researchers have discovered how to clone genes which previously were difficult or impossible to clone in large numbers. In medical research the discovery will help genetic engineers seeking causes and cures for cancers and other diseases by cutting down the time taken to multiply a gene from a single original. "Manufacturing" many copies of a gene is basic to studying its DNA code, and learning why a cell behaves in a certain way—for instance becoming cancerous.

There had been a problem in working on one gene out of many thousands in each cell because some genes cloned very inefficiently by the conventional method of reproducing them in certain strains of *E. coli* bacteria. Genes would clone in some strains of *E. coli* but not in others.

The researchers began testing strain of *E. coli*. A vital test system was cloning plant DNA because it has many methyl groups on it.

They were able to demonstrate that genes with lots of methyl groups on them were recovered at very low efficiency with conventional strains of cloning bacteria. But these genes could be cloned readily by using a mutant strain of *E. coli* that lacked an enzyme encoded by a gene called RGL. The RGL protein in normal bacteria interacts with methyl groups on DNA, acting to break down heavily methylated DNA and resulting in genes cloning inefficiently or not at all. Experiments proved that because it lacked the offending enzyme, the RGL-minus strain of *E. coli* permitted DNA to clone correctly.

Put the lights on for the horses

HORSES prefer to sleep with lights on. Katherine Houpt and Richard Houpt of Cornell University in New York State discovered this fact while studying horses in a windowless barn. The horses could turn a light on in the barn for 60 seconds by passing through the beam of a photoelectric cell, which they did at all hours of the day and night. The researchers found that the horses turned on the lights most often between 0600 and 1000 hours. The horses' need for light at this time of the day was due to circadian rhythm or not, was uncertain, because the horses still received cues from outside such as changes of temperature and noise. When the horses were free to move about in the barn they spent between 88 and 95 per cent out of the stalls.

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Diatoms determine death by drowning

DIATOMS (Bacillariophyceae) are a class of microscopic unicellular algae which are found in most natural waters where they get sufficient light to support their growth. There are about 15000 species of diatoms known to science. Diatoms are the inhabitants of both fresh and marine waters. They live either free or united to form colonies. Diatoms vary very much in size ranging from 5 μ m to more than 1000 μ m. Diatoms are unique in bearing the cell wall structure of hard siliceous box-like skeleton called frustule. Frustules contain hydrated silica which is chemically inert and almost indestructible. This chemical component of diatom cell walls has attracted the attention of forensic scientists.

Occurrence and the rigid siliceous cell wall of diatoms fetched them significance in diagnosing the deaths by drowning. Drowning is a form of death in which there is defective oxygenation of the blood in the lungs due to the presence of fluid in the respiratory tract, the fluid entering the air passages through the nose and mouth. It is generally accepted that during drowning in water microscopic plankton (viz., algae, plant fibres, etc.) penetrate into the lung capillaries, reach the left heart and are thus dispersed throughout the body by the arterial circulation. Death by aspiration of water is at the centre of the use of diatoms as indicators of death by drowning, since in this way they are introduced into the body from the drowning medium.

Diatoms are also disseminated by the blood stream throughout the body. Diatoms measuring even upto 40 μ m in diameter can easily enter the pulmonary circulation during drowning and arrive at various sites such as liver, kidney, brain and bone marrow. The number and variety of diatoms vary with their number and variety in the inhaled water.

Demonstrating diatoms in tissues is a simple, quick and inexpensive method. Organs which are suspected to contain diatoms are digested with corrosive acids like sulphuric and nitric acids. After the complete digestion of all the organic matter the

recovered. It helps in confirming the place of death.

The scientists believe that the presence of diatoms in the femoral bone marrow strongly supports the death by drowning. This also applies to brain tissues.

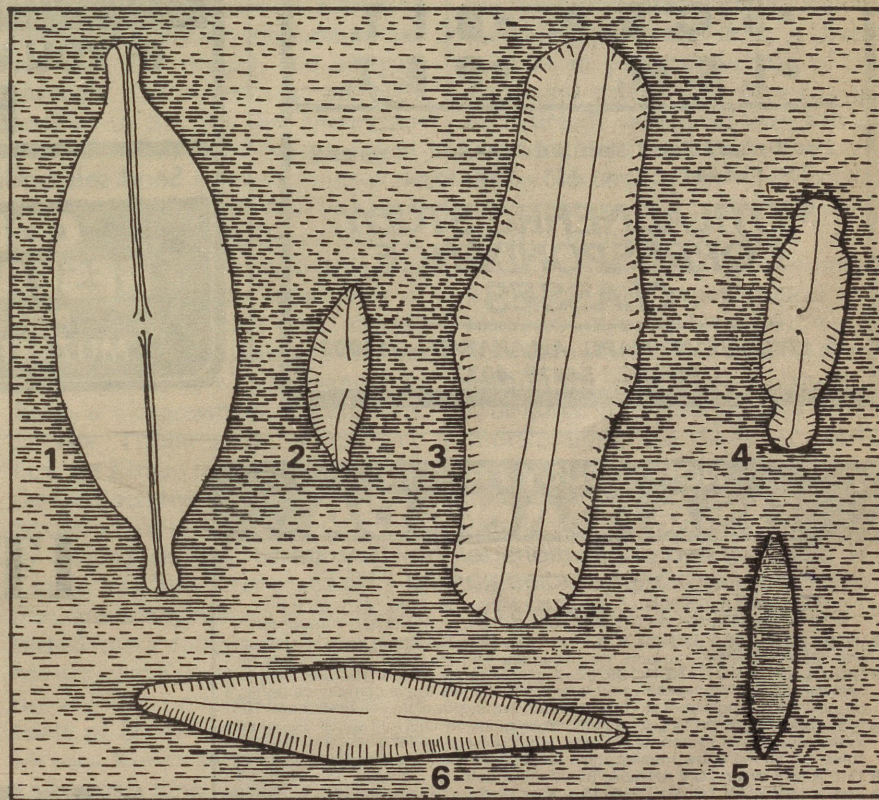


Fig. 1. Some diatoms recorded from drowned dead bodies (X 2000): (1) *Navicula cuspidata*; (2) *Cymbella ventricosa*; (3) *Rhopalodia gibba*; (4) *Pinnularia notata*; (5) *Nitzschia filiformis*; (6) *Gomphonema lanceolatum*

solution is examined for the presence of diatoms. The siliceous skeletons of diatoms can be easily recognised either in valve or girdle views. It may be noted that diatoms may not be found in extra-pulmonary sites if they are not present in lungs. Thus, lung examination for diatoms acts as a good screening test. Once the diatoms are found and identified in the tissues, it is necessary to compare them with the diatom flora of the water from where the dead body is

Significance of diatoms in determining deaths by drowning is not only reliable but also yields quick results. Diatom shells can also withstand the process of decomposition. Their presence has also been recorded in the tissues which had been mummified or converted to adipocere.

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BOOK REVIEWS

MANAGEMENT KURIEN-STYLE: The Story of the White Revolution by M.V. Kamath, *Konark Publishers Pvt. Ltd.*, A-149, Main Vikas Marg, Delhi-110092, Pp. 413, Rs. 150/-

THE concept of White Revolution and its architect V. Kurien have evoked both criticism and praise. While some critique has termed it as 'white lie' and 'a neo-imperialist plot to subvert the dairy industry in India' but to many other Kurien is a savior sent by God himself. Perhaps no other project has been subjected to so many reviews. The controversy on this subject is still persisting and perhaps it will continue to be so. Perhaps a project like this which affect the interests of so many divergent groups is bound to be controversial. White Revolution has certainly not solved the dairy problem in India which is evident from the fact that the Government has decided to tackle it on mission mode. The Dairy Mission is also based on Anand Model, where milk producers of a village are organised into a village milk co-operative managed by elected representatives who must also be milk producers. The village societies federate to a district union which is in turn federated into a state dairy federation. The genesis of White Revolution lies in the Kaira District Co-operative Milk Producers' Union Ltd and its dairy at Anand, Gujarat. So the legacy of the so-called White Revolution will continue to influence dairy industry in India. There have been many scholarly writings on White Revolution and co-operative movement in India. The present book under review has successfully attempted to project the human elements and personal contribution of Kurien and others in ushering the White Revolution. As one goes through the book it becomes apparent that the author is a great admirer of Kurien and what he did for the country but at the same time

the author has given due credit to all those who were involved in it. From the very beginning Kurien had the support from the highest level of the Indian Government. All the leading statesmen of the country, viz., Sardar Vallabhbhai Patel, Jawaharlal Nehru, Lal Bahadur Shastri, Morarji Desai, Mrs. Indira Gandhi and others took personal interest in it and without their active support it would not have been possible for Kurien to overcome many adverse circumstances that the project had to pass through. The contents of the book testifies to the fact that the author M.V. Kamath, a well known journalist, had to do a lot of home-work before putting the material into book form. Kamath has given an interesting account of the socio-economic ethos of the Patidar community of Kaira district which was mainly responsible for establishing the co-operative and how Tribhuvandas K. Patel, a Congressman, organised it. It was Tribhuvandas Patel who brought Kurien to be associated with the Co-operative's venture. The book has described in detail about the family and educational background of Kurien and how after graduating in mechanical engineering he eventually turned into a dairy man! The author has depicted Kurien's personal qualities and his commitment towards the cause of farmer in India. The fight between Kurien and Polson, the then uncrowned king in dairy industry, has been presented in great details. The logic and historical background behind establishing National Dairy Development Board (NDDB) and Indian Dairy Corporation (IDC) and formulation of Operation Flood I&II have been analysed. To give a comprehensive picture the author posed the important questions that were raised concerning Operation Flood before IDC and its responses are noted in the book. The book has also thrown light on how important decisions regarding a particular project are taken by the Government based on external factors instead of considering the merits and demerits of the project itself. The reader will get an

interesting insight on the functioning of our bureaucrats and how they protect the interest of certain groups. The author has analysed the reasons why the dairy industry could not equally flourish in all the states. The importance of the book lies in the fact that even if one does not agree with the author's viewpoint but it is still worth reading because the evolution of the concept of White Revolution has been presented with meticulous factual details and it is a lively account of personal feelings of the important people who were directly or indirectly associated with Kurien in his journey from an easy engineering profession to the highest and most controversial position in dairy industry in India. The book is not entirely free from shortcomings. There are some typographical and technical inconsistencies. It would have been better if the technical terms used in the book were explained in foot-notes. But whatever may be the shortcomings, the book is worth reading and it will certainly be a valuable addition to any library. Even the people who have nothing to do with dairy industry and its problems will find the book interesting but the high price may be a deterrent factor.

Subodh Mahanti

INTRODUCTION TO COMPUTERS by N. Subramanian, *Tata McGraw-Hill Publishing Company Limited*, 4/12, Asaf Ali Road, New Delhi-110002, pp. 315, Rs. 33.00

THE computer is fast becoming a necessity owing to its facility to hold large amounts of information and its capacity to work effectively on the information it stores. Today, it is a useful machine which helps in streamlining and integrating various systems. Today's industry and big

BOOK REVIEWS

business houses, scientific community, etc. depend heavily on it. This has created a demand for computer-trained manpower. Computers have to be introduced to the masses at an early age, right at the school level.

The book under review is designed primarily for Class XII students but shall serve equally well for various introductory courses offered at different schools, polytechnics, universities, etc. The book will be of interest to a general reader too. In its first four chapters, systems analysis is introduced. It touches upon problem definition, system design, system evaluation and ways to check software reliability. The chapter on access mechanisms deals with the ways in which logical data structure are stored on a storage device. File organisation and file access methods are also discussed. Rest of the book is devoted to developing principles of BASIC Programming and Boolean algebra. It also touches upon Assembly language programming. Every chapter is followed by a large number of unsolved problems meant to clear up doubts.

The book is well edited and contains a lot of descriptive flow diagrams, charts, etc.

The book will prove useful to students and general readers in arousing their interest in computers and in obtaining substantial knowledge.

Yogesh Sharma



EVERYDAY NEUROPATHOLOGY by K. Umansky, *Mir Publishers* (Available from U.S.S.R. Book Center, Connaught Circle, N. Delhi-110001), Pp. 312, Rs. 16/-

HOW do you relieve headache if you don't have (or don't want to take) an analgesic? Well, you simply do this: squeeze hard the bridge of the nose at its narrowest part for about a minute. You will feel better.

What do you do if you are suffering from insomnia and don't want to take a sleeping pill? Easy again. Take a warm bath before going to bed (Warning: the bath should be warm, not hot, and should not last more than 10-12 minutes).

What do you.... But wait. One can't go on like this. For a host of similar commonplace questions and their answers you could simply read this new interesting book by Umansky, a neuropathologist from the U.S.S.R.

In this age of information explosion, when human knowledge is doubling itself every five years, the common man who wants to acquaint himself with latest knowledge finds himself hopelessly left behind. For one thing, the available information is in a highly technical language and most people would not be able to make a head or tail of it. This is all the more true for superspecialities like neuropathology when even qualified doctors would get stumped at several places. A gynaecologist, for instance, would have little interest in an erudite work on neuropathology. He may even find several passages difficult to comprehend. Where does an ordinary man stand in this quagmire?

Well, the situation is not so bleak as it appears to be. In this little book, Umansky shows that even difficult subjects like neuropathology can be written in a non-technical and interesting language. Neuropathology is a branch of medical science which deals with diseases of the nervous system. You may not be interested in Guillain-Barre syndrome or Creutzfeldt-Jacob disease, but surely nervous disorders like headache, sleep, stroke, polio and alcoholism would interest you, and you would discover the answers to several generally asked questions about these diseases. Even regarding the earlier two formidable sounding diseases (and several others) you will read something in not so formidable language.

The book is full of interesting anecdotes and incidents which explain some aspect of diseases in an interest-

ing way. Some other incidents make you laugh heartily. The author once saw a 40 year old patient suffering from paralysis of the right half of the body. The paralysis occurred apparently by a stroke brought about by his chronic alcoholism. Boastfully the patient explains how he found after the fourth or fifth mug of vodka that he couldn't lift his glass. "What did you do then?" The doctor asked. "I picked it up with my left hand and continued drinking..." The patient replied.

Almost on every third or fourth page the author recounts such incidences and then goes on to explain the diseases in an interesting manner. This is certainly a book which can be heartily recommended to everyone, especially those who have a desire to know more about the human brain, its diseases and latest developments in their methods of treatment.

Anil Aggrawal



ROCKY SHORELANDS by Chris Packham, *William Collins Sons & Co., Ltd.*, London (Distributed by *Rupa & Co.*, 3831, Pataudi House Road, Daryaganj, New Delhi-110002) Pp. 128, £4.95.

ROCKY shorelands are one of the richest habitats in nature due to the continuous interplay of the elements of nature at the confluence of land and sea. Sea-water has interacted with rocks for millions of years to create an environment which supports myriad biological forms such as sea urchins, starfish, brittlestars, sea cucumbers, jellyfish, crabs, fishes and sea weeds. Many kinds of birds inhabit shorelands and mammals of the deep sea come ashore to breed. However, the harsh environs of a rocky shoreland do not allow many flowering plants to grow easily.

All these details come alive in the

BOOK REVIEWS

book under review. The book is however confined to the rocky shore life of Britain. It begins with the formation of these shorelands, gives a general account of their geology and goes on to describe various life forms. It describes different organisms, their physiology and the interplay of ecological factors which sustain them. Interesting accounts of toxins from sea anemones, symbiosis between anemones and algae, camouflage in fish, economic importance of sea weeds, physiology of salt tolerance of flowering plants and their subsequent limited spread, etc., are given in the book.

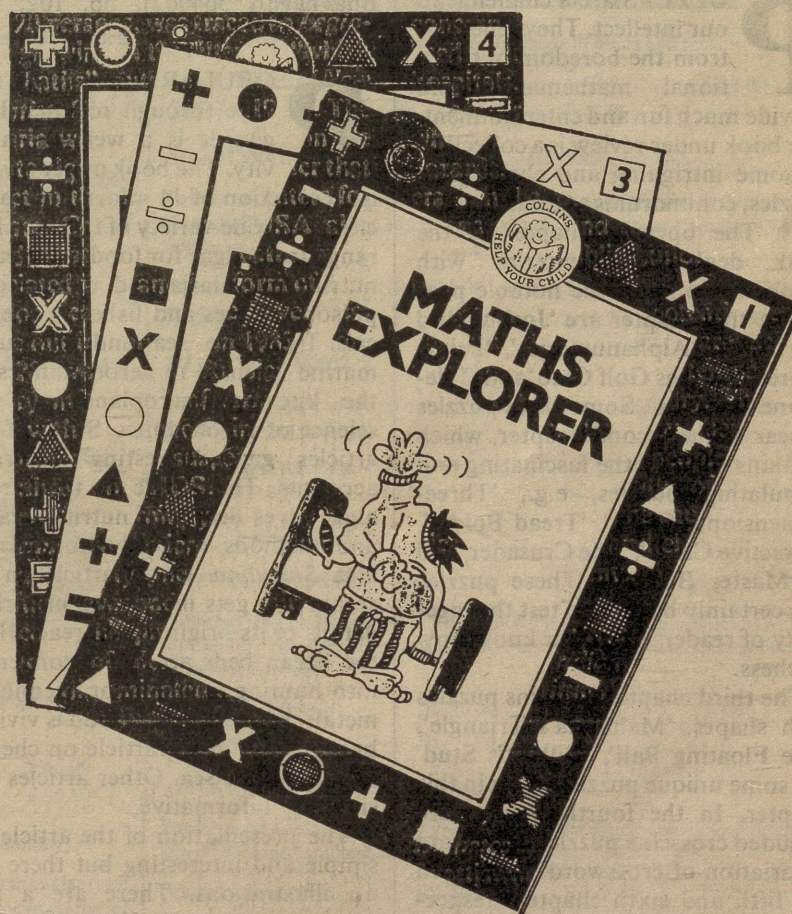
The British Isles are one of the world's outstanding seabird stations. A large number of some species that nest there represents a good proportion of the world's total population. These birds' nesting, feeding and breeding behaviour are described in the book.

The book is profusely illustrated with coloured photographs and four coloured identification plates of superb quality. The combination of pictures and descriptions enables one to identify most of the species that may be encountered in a rocky shore habitat. Though the book deals with the British shorelands, many organisms found there are also seen on the long coastline of India.

N. R. Mankad

figures also do not mean much except to be copied and drawn. Teachers are in a hurry to complete the course and parents are keen that their children should score the highest marks. Neither teachers nor parents have enough time or patience to teach children the real purpose of numbers and figures. But, then, how to break this vicious circle in these days of

toons, quizzes, crosswords and a wide range of games and tricks. Sometimes, children have to use colours to solve a puzzle. Answers are provided at the end of each booklet. Children need only know English. As every page of each of these booklets contains one game or puzzle a child can take one puzzle or game a day, solve it and show it to his or her



MATHS EXPLORERS 1 to 6 by Alan Brighthouse, David Godber and Peter Patilla, *Collins* (Distributed by *Rupa & Co*, 3831, Pataudi House Road, Daryaganj, New Delhi-110002), each about 30 pages, each Rs. 21.00

CHILDREN often find mathematics hard and dull because teachers do not relate it to their day-to-day life. Numbers are simply to be added, subtracted, multiplied and divided for unknown reasons. Geometrical

rat-race and competition, of which children are also a part?

In such circumstances, the *Collins Help Your Child* series of booklets on mathematics under review would prove to be of immense value to children between 5 and 11. Efforts have been made in these booklets to introduce the basic concepts of numbers and their operations, geometrical figures and their purpose etc., to children through pictures, car-

parents before going to bed. Of course, a precocious child would sit for hours on end and finish each one of the booklets at one go.

Although the price of these booklets is on the higher side, each one is worth buying. Low-priced Indian reprints could make them best-sellers in the Indian market.

Dilip M. Salwi

BOOK REVIEWS



THE TICKET TO HEAVEN and Other Superior Puzzles by Tim Sole, *Penguin Books* (Available with: Penguin Overseas Ltd., 708, Eros Apartment, 56, Nehru Place, New Delhi-110019), Pp. 192, £ 6.99.

PUZZLES are a challenge to our intellect. They relieve us from the boredom of traditional mathematics and provide much fun and entertainment. The book under review is a collection of some intriguing and challenging puzzles, conundrums and chess problems. The opening chapter of the book deals with puzzles with numbers. Some of the notable puzzles in this chapter are 'Joshua and His Rats', 'Alphanumeric', 'Prime Scores', 'Smugs Golf Club' and 'Telephone numbers'. Some chess puzzles appear in the second chapter, which contains some of the fascinating and stimulating puzzles, e.g., 'Three-Dimensional Chess', 'Tread Boldly', 'Detective Chess', 'The Crusader' and 'A Master Blunder'. These puzzles will certainly be able to test the ingenuity of readers and their know-how of chess.

The third chapter contains puzzles with shapes. 'Mahatma's Triangle', 'The Floating Ball', 'Gilbert's Stud' are some unique puzzles given in this chapter. In the fourth chapter are included crossclue puzzles, which are a variation of crossword puzzles. In the fifth and sixth chapters respectively are presented 'Puzzles for Clear Thinkers' and 'Miscellaneous Puzzles'. The last chapter 'Supplement' discusses some more complex puzzles. The number play discussed in this chapter is simply superb. Could you think that using a single 4 it is possible to write numbers like 231, 300, 720, 1540, etc.? There is a lot in the book for clear thinkers, intellects and those who are interested in playing and doodling with numbers. The readers will find many mind teasing puzzles in the book which are simply

brilliant! Certainly, a praiseworthy effort!

P.K. Mukherjee



VIGYANPATH by Kishor Pandya (In Gujarati), K.S. Pandya, 44, Sahyognagar, Gujarat Housing Board, Bilimora (Available from 'Prasar', 1888, Atabhai Avenue, Bhavnagar, 364002), pp. 102, Rs. 15/-

POPULARISATION of science through regional languages is a welcome activity. The book under review is a collection of 14 informative articles on a wide variety of topics. They range from algae for food, ice cream, nutrition, malaria and mosquitoes, poisonous dyes and fishes to chemicals from the sea and intriguing marine animals to aerodynamics of the kite and aeroplane and the science of pyrotechnics. Some of the articles give interesting historical accounts. The article on food from algae gives details of nutritive value and methods of cultivation of the alga *Spirulina*. In the article on ice cream one gets interesting historical details of its origin and spread. How the ocean beds are being converted into hunting grounds for chemicals, metals, petroleum and food is vividly brought out in the article on chemicals from the sea. Other articles are similarly informative.

The presentation of the articles is simple and interesting but there are no illustrations. There are a few printing errors too. However, these in no way should reduce the utility of book which is moderately priced. It is a useful addition to the scanty literature on popular science in Gujarati.

N.R. Mankad



ANTARES DAWN by Michael McCollum, *Grafton Books* (Available from: *Rupa & Co.*, 3831, Pataudi House Road, Daryaganj, New Delhi-110002), pp. 333, £ 1.95.

THE thrill and romance associated with space travel fascinates most of Science Fiction writers. That is the reason why space travel is one of the most popular themes in many science fiction plots. The novel under review is also centered on space travel. A Supernova explosion takes place in the star Antares, as a result of which the Altan civilisation is cut off from the rest of the humanity. For more than a century the Altan Society is near stasis. No interstellar travel is possible; interstellar trade comes to a standstill.

Then Richard Drake, the commanding officer of the Altan Space Navy Cruiser *Discovery*, Suddenly discovers a starship. This turns out to be *Conquerer*, a ship from the planet Earth. However, aboard this starship are found only dead bodies of Earthmen. The mystery gets deeper! The reader leafs through the novel curious to get a clue as to what is actually behind this mystery.

The six-legged aliens Ryalls have natural animosity against humans. These awesome aliens give a tough fight to the inhabitants of Sander-son's World. Are these aliens also responsible for the death of the Earthmen in the ill-fated starship *Conquerer*? One has to go through the novel to get the answer. Suspense holds the breath of the reader. Certainly, an action-packed novel which will also entertain the reader.

P.K. Mukherjee

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1. **ISOTOPES IN THE ATOMIC AGE** by H.J. Arnikar, *Wiley Eastern Ltd.*, 4835/24, Ansari Road, Daryaganj, New Delhi-110002, Pp. 265, Rs. 150.00
2. **HORIZONS OF PHYSICS (1)** Edited by A.W. Joshi, *Wiley Eastern Ltd.*, 4835/24, Ansari Road, Daryaganj, New Delhi-110002, Pp. 383,
3. **SCIENCE TEASERS & MORE SCIENCE TEASERS** both by Dilip M. Salwi, *Konark Publishers Pvt. Ltd.*, A-149, Main Vikas Marg, Delhi-110092, Rs. 30 each, Rs. 95 (hardcover) each

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