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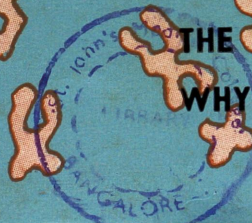
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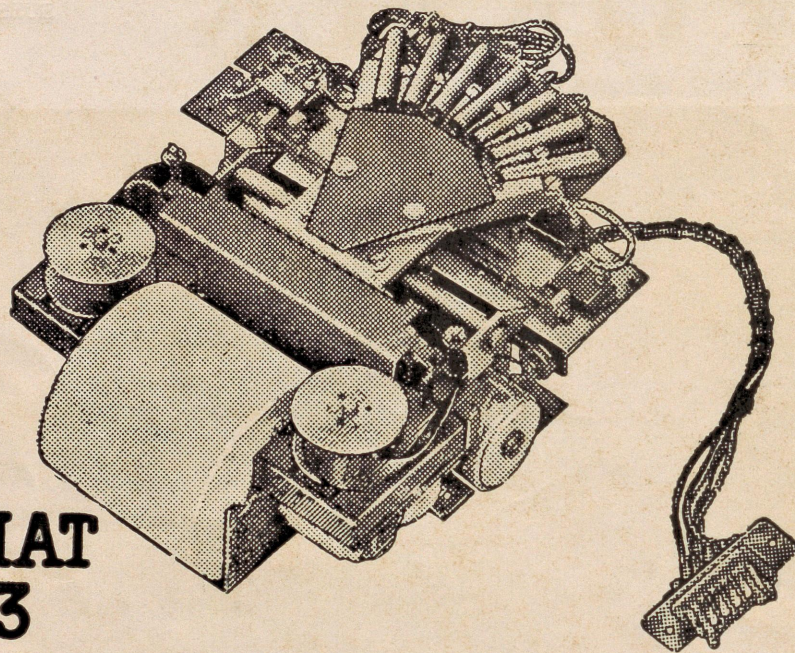
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Science Congress 1977

Sir, It has been painful for me to go through the sweeping and damaging remarks levelled against the 64th Indian Science Congress held at Bhubaneswar in January, 1977, in your magazine (*S.R.* February, 1977). The session has been branded as dull, uninteresting, and a wastage of time, national wealth and science talent.

The session was attended by about 2600 delegates drawn from all over the country including 51 foreign scientists representing well-known scientific organizations in different countries of the world. More than 400 papers were read in 13 sections, most of them by young scientists. Dr. H. N. Sethna, Chairman of the Atomic Energy Commission, was the General President and the thirteen sections, namely, (1) Mathematics, (2) Physics, (3) Chemistry, (4) Botany, (5) Zoology, Entomology and Fisheries, (6) Anthropology and Archaeology, (7) Medical and Veterinary Sciences, (8) Agricultural Sciences, (9) Physiology, (10) Psychology and Educational Sciences, (11) Statistics, (12) Geology and Geography and (13) Engineering Sciences, were each presided over by an eminent specialist in the field. In addition, presentation of papers was also done under the Committees and Forums: (1) Science and Public Relations, (2) Science and Economic Development, and (3) Home Science and Nutrition. The focal theme for the session was survey, conservation and utilization of resources, under which

discussions were held and a very educative exhibition was arranged. The foreign scientists not only participated in discussions under various sections, but also delivered popular lectures on topics of absorbing interest like, *Viking mission and the search of life beyond earth* by Dr. Cyril Ponnampuruma (U.S.A.), *Science and natural calamities* by Academician M. A. Lavrentev (USSR), and *The Fishery Resources of India and their utilization* by Dr. V. G. Jhingran, Director, Central Inland Fisheries Research Institute, Calcutta.

The Indian Science Congress Association is an organization like the British Association for the Advancement of Science and the American Association for the Advancement of Science and holds its annual session in a city or big town for the benefit of exchange of ideas and personal contact among its members, over a period of five days in the first week of January. During the period, the local organizers arrange whole day, half day and short local excursions to places of interest. Scientists, their spouses and children who accompany them try to snatch out an afternoon or a day to go out for sight-seeing. Scientists are human too, they eat, drink, need rest and recreation like any other normal human being. It is unfortunate to brand the participants of the Bhubaneswar session as 'not scientists but tourists'.

A congress is a rendezvous, where participants contribute and the success of the conference depends upon how the participants take part in it. Some articles in the *Science Reporter* may appear to me dull, and I may feel it a waste of time to read through it, because I am not interested in the subject matter. Does that mean the magazine contains trash and it is a waste of national wealth to publish the magazine? *S.R.* is a popular scientific magazine. The annual session of the Science Congress is a session of scientists.

Why compare a scientific session with a magazine? What is expected of the scientists attending the annual session of the Science Congress to perform acrobatics to make it lively and amusing for those who are not interested in the scientific deliberations? I have almost regularly been attending the annual sessions of the Science Congress during the last 27 years. Some critics have branded the sessions as a 'Vigyan mela', 'Dusserah of scientists', 'Graveyard of science', etc. I have found the sessions very educative.

In the last congress, the national policy on science was discussed. What else could have been done? Certainly, the organizers of the 65th Science Congress at Ahmedabad, 1978 will deeply appreciate to have constructive, realistic and operational suggestions as to how it can be made more lively and useful to the common man. Indian Science Congress Association is an association of scientists and for those who have aptitude and love for it, and not for those who do not find interest in the deliberations.

B. K. BEHURA
Professor of Zoology
Utkal University, Vani Vihar
Bhubaneswar-751004 (Orissa)

Particle physics

Sir, History of particle physics by Dr. V. Mukherji (*S.R.* April, 1977) should be an eye opener to the academicians of our country. That the article has had a style of its own by presenting the world of particle physics in a lucid manner is, however, not the reason. There is an inherent message in it. In our colleges and universities we spend a lot of time learning how a certain theory was conceived of and how certain experiments proceeded from its crude stage to the ultimate stage of perfection. For example, starting with corpuscular as well as wave

theory of light we struggle through the school and college days and ultimately learn at the university stage that the two aspects are complementary, two manifestations of the same effect.

In this way, we spend more time in swallowing the history of science rather than science itself. History of science is equally enchanting as has been proved by Dr. Mukherji's article. Our academicians should think deeply about introducing it as a subject in our educational institutions.

B. K. SARMA
Asstt. Geophysicist
Electrological Section
ONGC, Ankleswar-393010
Gujarat

Weed menace in India

Sir, Here is a clarification regarding the letter of Mr. K. L. Mahadevappa (S.R., May 1977).

Teleonemia scrupulosa or lantana lace bug was first introduced in India by Dr. Beeson of F.R.I., Dehra Dun in 1941. It was found that the insect damaged teak also. Therefore, FRI destroyed the initial stock in 1943. Later, in 1951 there was an accidental appearance of a single *Teleonemia* in F.R.I. Since then, it has spread in wide areas. F.R.I. had also sent consignments of this bug to South India and East India.

I have corresponded with the Forest Entomologist, F.R.I. who is of the opinion that the insect found by Mr. Chandrasekhar Luhumi is the same insect (*Teleonemia scrupulosa*) as introduced at F.R.I. The Forest Entomologist is of the opinion that the insect is specific to lantana. Although it is a sap sucker causing defoliation, it is not capable of killing the lantana bushes. Hence, two more exotic lantana insects namely, *Octotoma scabriennis* and *Uroplata girardi* have been introduced at F.R.I. These are leaf miners

and are specific to lantana. They have been released in the field also.

V. BHASKAR
Asstt. Professor of Farm Forestry
University of Agricultural Sciences,
Bangalore, India.

Phobos and Deimos

Sir, The article **Moons of Mars** by Dilip M. Salwi (S.R., July 1977) was topical and informative, like his other articles in S.R. and elsewhere. The author has stated that the moons of Mars, Phobos (Fear) and Deimos (Panic), have been attributed these names for unknown reasons. Actually they have been thus named purposely, for are not fear and panic suitable companions to the God of War (Mars)?

Phobos and Deimos have been mentioned as the charioteer sons of Ares (Mars) according to the Greek mythology. The Romans consider them to be the chariot horses of Mars, driven by a demented woman.

The orbital period of Phobos is given as 7.7 hrs, which, as a matter of fact, is less than the rotation period of Mars. Phobos is the only satellite known in the solar system which revolves in a shorter interval than the rotation period of its primary. The sixth satellite of Uranus, the discovery of which was reported recently by J. C. Bhattacharyya and S. Kuppaswamy, may share this honour, but even then it will come only as a second best. No wonder, at one time Phobos was considered to have been launched by intelligent Martians.

The orbit of Phobos is unique, because of its closeness to the planet and is just outside the Roche's limit. If it were inside the limit, the gravitational force of Mars would have torn Phobos asunder.

Regarding composition of Phobos, Prof. J. Veverka of Cornell University reported early this year that it

was of carbonaceous chondrite. On 16th Feb., 1977 in a lecture at National Physical Laboratory, New Delhi Prof. W.H. Pickering of California Institute of Technology and ex-Director, Jet Propulsion Laboratory remarked that its composition was essentially of iron. "If we could bring it (Phobos) to earth it will keep us in business for a couple of years," he had remarked jocularly.

S. K. GURTU
Defence Science Lab.
Metcalf House
Delhi 110054

About linear programming

Sir, In **About linear programming** (S.R., July 1977) Mr. R. Ramaswamy has shown how a simple two variable problem can be solved by using linear programming. The general linear programming problem can be written as:

$$\begin{aligned} & \text{Minimize or maximize } f = \sum_{j=1}^n c_j x_j \\ & \text{Subject to } \sum_{j=1}^n a_{ij} x_j \geq b_i, \quad i=1, 2, \dots, m \\ & \text{and } x_j \geq 0, \quad j=1, 2, \dots, n \end{aligned}$$

This cannot be solved by using the graphical method. If the constraints are 'greater than' or 'less than', we have to subtract or add a variable which is called a 'slack' variable. We may also have to introduce artificial variables if the formulation is not in the canonical form. One more advantage of linear programming is its duality.

Linear programming applications span a remarkable variety of subjects, from agriculture to economics, from petroleum refining to engineering. T. C. Koopmans in the U.S.A. and L.V. Kantorovich in the U.S.S.R. have applied linear programming to economics for which they were jointly awarded Nobel Prize for economics in 1975. Readymade computer programs are available in

all computer centres and solutions can be obtained in minutes.

N. SUBRAMANIAN
Senior Research Fellow (CSIR)
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Prostacyclin

Sir, I read **Significance of prostaglandins** by Dr. U. N. Das (S.R., July 1977) with great interest. But the article has not given even a line about the newly discovered prosta-

glandin known as PGI₂ or prostacyclin. The first report on prostacyclin came from Wellcome Research Laboratory of United Kingdom (*Nature*, 263, 263, 1976). S. Moncada *et al.*, while working on an enzyme system, isolated it from arteries of rabbit and pig. This unstable and new prostaglandin which is a transformation product of prostaglandin endoperoxides was named PGX by the same group of workers. Dr. U. N. Das writes in his article that PGE inhibits aggregation of platelets, but this new prostaglandin is 30 times more potent in this respect than PGE.

Later, this PGX was named as PGI₂ by C. Pace-Asciak (*J. Am. Chem. Soc.*, 1976, 98, 2348).

Recently, a report from Netherlands appeared in *Nature* (vol. 268, pages 160-163), by E. A. M. De Deckere *et al.* about release of prostacyclin from the isolated perfused rabbit and rat heart. Prostacyclin is formed by microsomes from several organs such as pig and rabbit aorta, rat stomach and by fresh human arterial and venous tissues when incubated with PGH₂ as described by S. Moncada *et al.* (*Lancet*, 1977, i, 18-22). PGI₂ helps in pre-

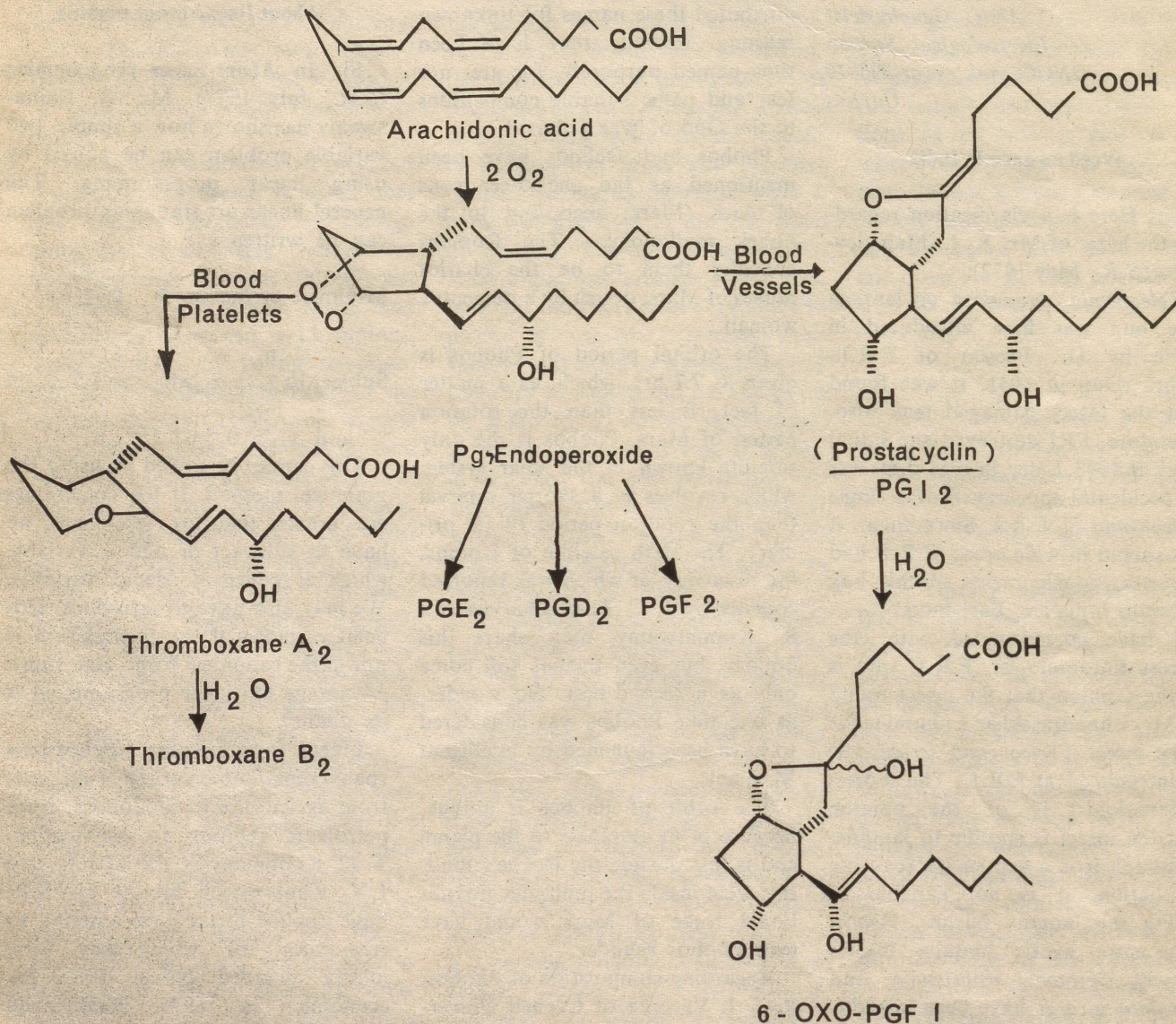


Fig Formation of prostacycline, PGI₂

venting the formation of intra-arterial thrombi. Prostacyclin is chemically unstable in aqueous media and is rapidly hydrolyzed to 6-oxo-PGF₁ (Fig. 1), which does not inhibit blood platelet aggregation. Considerable amount of this substance, 6-oxo-PGF₁ in the perfusates suggested that prostacyclin is the major prostaglandin released from the heart.

The production of prostacyclin from heart and its anti-aggregating property, according to De Deckere, indicates that the main function of this prostaglandin is to protect coronary circulation against the formation of platelet aggregation and thus prevent the occlusion of small branches of the vulnerable coronary tree. If the results worked out by these workers are extrapolated to human heart, prostacyclin could be a key substance in prevention of coronary diseases.

RAI AJIT KR. SRIVASTAVA
Biochemistry Deptt.
RRL, Jorhat-6 (Assam)

Allergy

Sir, I have been reading with great interest various articles in the field of medical science and biochemistry published in your journal from time to time. I am interested in the latest research findings in the field of allergies—especially the intermediary toxic substances produced during antigen-antibody reaction. Of late, there has been a controversy over the type of certain toxic substances like histamine, serotonin and bradykinin produced in different sensitive organs of a patient. While the popular belief is that histamine is produced in the lungs as a result of the antigen-antibody reaction, some workers feel that a substance other than histamine is produced in the lungs which renders antihistaminics against asthma ineffective, though for nasal allergy these agents work better.

Can any of your readers elucidate

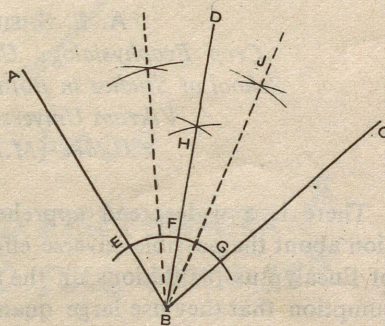
this point and inform precisely what type of chemical is produced in the lungs as a result of the above reaction, which triggers off the spasm in bronchial asthma?

MANOHAR T. SANTWANI
Deputy Director
Indian Standards Institution
New Delhi-110002

Can you trisect an angle?

Sir, Trisecting an angle is a problem which still baffles a geometrician. I have found the following method of trisecting an angle.

Take any angle ABC, whether acute or right-angle or obtuse, and draw its bisector BD. Taking B as centre, draw a suitable arc to cut the angle arms and the bisector at E, G, and F respectively. Now taking F as centre, again draw the same arc to cut BD at H; and then taking H as centre draw a circle, the radius being the same as before.



Now taking points E and G as centres draw arcs of radius twice the radius of the above arcs. In other words, the radius of the arcs should now be 2BF or BH. The arcs would cut at I and J. Join IB and JB. The lines IB and JB trisect the angle ABC.

B. VIJAYAN
T.K.M.M. College
Nangiarkulangara, Kerala

Civil engineering

Sir, I am thankful to you for the article **Sedimentation in Indian reservoirs** (S.R. June 1977). The article is of absorbing interest to students of civil and agricultural engineering. We request you to publish more articles on subjects of civil engineering (such as failure of bridges, dams, etc.) which will interest us to take up research studies on these topics.

G. KONDALA RAO
4/5, B. Tech. (Civil)
College of Engg.
Kakinada (A.P.)

Emulsions

Sir, I read S.R. regularly with great interest. It is very useful for science students. I think there is immense importance of applications of emulsions in our daily life. I would request you to publish an article on "Emulsions, its importance and applications".

LOKNATH GHOSH
Research Worker
Department of Food Technology
& Biochemical Engineering
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Calcutta-700032

Crocodile skin

Sir, I would like to know the names of crocodiles whose skins (S.R., April 1977) are very expensive. Also, how the price of a skin is determined. How do you kill the animal?

A. ESWAR
R.B.S. College, Bichpuri
Agra-5

There are three types of Indian crocodiles: (1) *Gavialis gangeticus*, the long snouted fresh water crocodile; (2) *Crocodylus porosus*, the short snouted salt water or estuarine or marsh crocodile; and (3) *C. palustris*,

the short snouted mugger or fresh water crocodile.

The skin of the salt water crocodile, *C. porosus* is highly expensive because it has smaller scales on its body, whereas the mugger, *C. palustris*, has large scales on the belly and so its skin is less expensive. The gharial is a medium scaled crocodile.

Generally, crocodiles are killed by a sharp weapon or by axe or by shooting. Poachers usually kill by shooting and hooking. Hooks, fixed to a chain, are placed on the favoured basking site. When the crocodile comes out to bask, it is hooked.

Due to high prices of crocodile skins in European markets (one sq. inch of the crocodile skin fetches about Rs. 40/- in Europe), crocodiles are fast depleting.

MADIREDDI V. SUBBA RAO
Post-Graduate Deptt. of Zoology
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Amoebic dysentery

Sir, I would like to point out an inaccurate statement in the article of Sohail Ahmed on Amoebic dysentery—a serious health problem (*S.R.*, March 1977). He mentioned that "chlorination of water and washing the vegetables with chlorine solution are quite effective in preventing an infection". On the contrary, the following statement is worth noting: "A water system that provides standard chlorination and piped delivery will not ordinarily be safe as regards amoebiasis without effective filtration, since water can carry amoebic cysts. Hyperchlorination is required to kill amoebic cysts, and this is unacceptable on two counts: high cost and objectionable flavour. Filtration is therefore essential whenever chlorination is required" (*Technical Report Series No. 421 on*

Amoebiasis published by WHO in 1969).

Regarding the treatment, an oversimplified statement has been made. There are drugs, no doubt, but their efficacy principally depends on the site of the infection.

DEVABRATA SETH
Deptt. of Parasitology
Sarabhai Research Centre
Baroda-390007

Eucalyptus

Sir, I read the article *Advantages of eucalyptus growing* (*S.R.*, Feb. 1977, p. 112). I would like to draw the attention of the author that, in spite of the advantages of growing *Eucalyptus* in our country, this genus has a serious disadvantage. *Eucalyptus* is a phreatophyte, and consumes water from permanent water table. Owing to its higher consumption of water, groundwater is depleted, resulting in water scarcity. So, large scale plantation of this genus may be harmful in future.

A. S. SHEIKH
Crop Ecophysiology Unit
School of Studies in Botany
Vikram University
Ujjain (M.P.)

There is a widespread apprehension about the possible adverse effect of Eucalyptus plantations on the assumption that they use large quantities of water and affect local water supplies. This has its origin in the reclamation work of the Pontino marshes in Italy where *E. robusta* and *E. rostrata* were extensively planted. The capacity of these two species to grow under swampy and waterlogged conditions are characteristic features of these species which cannot be attributed to all other species numbering over 3000. The species vary—some capable of growing in semi-waterlogged conditions and others in very arid

areas. In Australia, species like *E. brockwayi*, *E. salubris*, *E. salmophloia*, *E. siderozylon* and *E. transcontinentalis*, grow naturally in areas having mean annual rainfall of 200-640 mm. If all these species were so extravagant about water, they would have ceased to exist in these areas which by now would have turned into desert.

In India, Eucalyptuses have been tried for raising large scale plantations in the country as they have almost all the desired qualities of wood required for both domestic and commercial purposes. In Punjab, Haryana, and U.P., where *Eucalyptus tereticornis* is being grown along the roadsides, canal banks or on the field bunds, high yielding wheat crops are being grown under intensive irrigation. Perhaps use of water by the agricultural crops is one of the main reasons for the depletion of ground water resources in such areas.

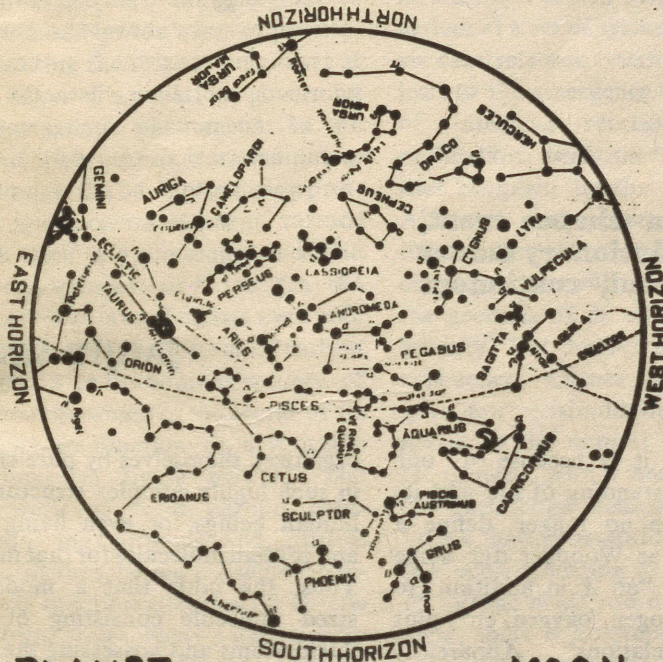
It has been observed that ever-green ground vegetation thrives under Eucalyptus plantations, which indicates that the plantations have profound influence on soil-moisture conservation. Investigations carried out both in India and Israel have shown that loss of rainfall due to interception is lower (less than half) in Eucalyptus as compared to other broad-leaved species such as sal, teak, khair, etc.

Studies on the annual transpiration rate of *E. globulus* in the Nilgiris have shown that out of 130 cm of rainfall only 35 cm get transpired. Also, Eucalyptus roots penetrate to shallower depths in comparison to others, which shows that the plants generally do not tap deep ground water reservoirs, which other deep-rooted species are very likely to do.

It has been experimentally proved that water consumed per unit gm. of diameter produced was the least in *E. tereticornis*, i.e., 1.41 mm as against 2.59 for *Dalbergia latifolia*.
(Continued on page 658)

Planets and their positions

NOVEMBER 1977



PLANET

MOON

4 JUPITER

MAGNITUDES

1 0 .1 2 3 4 5
◆ ● ● ● ● ● ●

☾ FIRST QUARTER 18th

○ FULL MOON 25th

The moon

NEW moon occurs on 11th at 12-39 p.m. and full moon on 25th at 11-01 p.m. I.S.T.

The moon passes about five degrees south of Jupiter on 1st, about seven degrees south of Mars on 3rd, five degrees south of Saturn on 5th, is very close to Venus on the 10th, is

about six degrees north of Mercury on 12th and again about four and a half degrees south of Jupiter on 28th.

The lunar crescent becomes first visible after the new moon day in the evening of 12th.

The moon is at perigee or nearest to the earth on 12th and at apogee or farthest from it on 28th.

An occultation of the planet

Venus by the moon will occur in the early hours of 10th. It will be visible in strong twilight at Madras from 5-29 a.m. on the eastern horizon. The sun rises at Madras at 6-05 a.m. before the time of emersion.

The planets

Mercury (Budha) is too near the sun to be visible during the first half of the month. Thereafter, it reappears as an evening star and sets about an hour after sunset. It passes three degrees north of the star Antares (*Jyestha*) shortly after midnight of 15th. It moves from *Libra* (*Tula*) to *Sagittarius* (*Dhanus*) through *Scorpio* (*Vrischika*). Its visual magnitude is about -0.3.

Venus (*Sukra*), a morning star, rises about an hour before sunrise during the month. It passes four degrees North of the star Spica (*Citra*) in the very early hours of 4th. It moves from *Virgo* (*Kanya*) to *Scorpio* (*Vrischika*) through *Libra* (*Tula*). Its visual magnitude is about -3.4.

Mars (*Mangala*), visible in the morning sky, rises about one and a half hours before local midnight during first half of the month and about two and a half hours before it during the second half. It is in *Cancer* (*Karkata*). Its visual magnitude varies from +0.4 to -0.2.

Jupiter (*Brihaspati*) rises about three and a half hours after sunset during the first half of the month and two and a half hours after it during the second half. It is in *Gemini* (*Mithuna*). Its visual magnitude is about -2.2.

Saturn (*Sani*), visible in the morning sky, rises at about local midnight during the month. It is in quadrature with sun on 22nd. It passes very close to the star Regulus (*Magha*) in the evening of 3rd. It is in *Leo* (*Simha*). Its visual magnitude is about +0.8.

(Source: Nautical Almanac Unit of the Meteorological Office, P-546, Block 'N' (1st floor), New Alipore, Calcutta-53).

THE ORIGIN OF LIFE : Chance or Necessity ?

The beginning of life may have been a chance event, but thereafter its progress along the evolutionary ladder all the way to man was an uninterrupted, continuous process

JAGJIT SINGH

IT is curious that despite the antiquity of life our knowledge about its origin, fragmentary as it is still, is so recent. The earlier ages had, no doubt, their theories. But their authors, totally ignorant of the complexity of the problem, had naive ideas as to how life actually arose on earth. As usual, the greater the ignorance, the more pompous the verbiage devised to mask it. *Generatio acquivoca, generates primaria* expressed the belief that fully formed living organisms arise miraculously out of non-living matter. Since one miracle deserved another, life's miracle on earth could be repeated with equal facility and abundance everywhere. This is why some sober pioneers of stellar astronomy like Sir William Herschel felt fully authorized on 'astronomical principles' to populate even the sun with innumerable inhabitants! If there is now greater sobriety in the appraisal of the possible existence of life in

the universe, it is because of our greater understanding of life and its processes. We no longer define a living being, as Woodger did some time ago, as "an X in addition to carbon, hydrogen, oxygen, etc., plus organizing relations". Apparently the mysterious X-component was thrown in because of the alleged statistical improbability of a random mixture of the aforementioned elements ever forming the basic materials of life, enzyme proteins, nucleic acids, and other specialized structures by a purely 'fortuitous concourse of atoms'.

As recently as the 1950s the biologist, Lecomte de Nöuy, had argued that if the universe is merely a medley of randomly moving molecules and if the ultimate particles like electrons and protons build up atoms, and atoms build molecules, and molecules colloidal particles, and so on, then it is practically impossible that the ultimate particles could have

organized themselves by pure chance in such highly complex structures as human beings, or even living cells and protein molecules for that matter. Thus, the odds that a moderate-sized molecule consisting of, say, 2,000 atoms and possessing the same degree of asymmetry as a protein molecule should arise by random processes are roughly one in 10^{318} against it. These odds are so large that we might as well concede that the occurrence of life is a *miracle* requiring an act of special creation and thus hand over the problem to theology and metaphysics. But the argument is no better than that of a bridge player who, having been dealt with a bumper hand, cites the event as proof of providential intervention. Every hand, bumper or otherwise, has a very small chance of occurring. But if we begin to deal the cards some hand, no matter what its chance *before* the deal, has to occur. Once it has occurred we can-

not claim that its occurrence is due to the working of some special contrivance, because of its low *before-the-deal* chance of occurrence.

The answer to de Nöuy's argument lies in showing that the basic laws governing the behaviour of matter are such as could have led to the genesis of life by a natural process rather than by the fiat of an Almighty God. To do so we have to search for and formulate the organizing principles that led to the emergence of life, such as Newton's law of gravitation making the solar system what it is, or Maxwell's equations governing electromagnetic phenomena. In the case of life's genesis from inanimate beginnings, the basic organizing principle is the chemical law of valence which itself is a consequence of the inherent structure of atoms. On the basis of these laws chemists were able to explain the great power of carbon to form a multitudinous variety of compounds which is the secret of its capacity to function as a veritable backbone of living matter. The emergence of these carbon compounds—the proteins and nucleic acids—is thus merely the self-realization of the potentialities of atomic electronic states. Nöuy's objection to a naturalist origin of life on account of its statistical improbability disregards the chemical basis of life. It tacitly assumes that *all* permutations of atoms are *equally* likely in total disregard of the fact that most permutations are excluded by the electronic structure of atoms while some others are heavily favoured. His argument therefore is of a piece with the statistical 'deduction' that since the chance of even a single meaningful sentence in Shakespeare's works arising by a random strumming on a typewriter is infinitesimal, no such work could ever arise! The fallacy lies in ignoring the mechanism responsible for stringing letters of the alphabet in one case and atoms in the other. If we pay due regard to the chemical proclivities of

atoms built into their electronic structure and treat the question of origin of life as a problem of chemical kinetics and thermodynamics, we find that emergence of life, far from being a highly improbable event, is all but inevitable, given the right conditions.

A. B. Zahlank has shown how life could arise as a result of random and purely chemical events. Taking catalysis as the main agent and using information theory and topology, he arrives at a set of systems with about six catalysts per system which could lead to the emergence of a sequence of chemical reactions involving replication, performed on metabolites supplied by the environment. Although such schemes are purely formal, they do expose the error in denying a natural origin of life on the grounds of its statistical improbability. But Jaques Monod in his best-seller, *Chance and Necessity*, gave new verisimilitude, if not actual proof, to the natural origin theory. He showed, with a wealth of chemical knowledge seasoned with immense literary erudition, that once a few self-replicating macromolecules of nucleic acids, we now call genes, arise, there is no stopping of evolution of life from this self-replicating macromolecule all the way to man as an increasingly complex crescendo of self-sustained patterns of chemical reactions.

The crucial property of this macromolecule, or 'seed of life', is what he calls *reproductive invariance*. By this he means the capacity of a highly ordered structure like a gene to reproduce itself. Since a structure's degree of order can be defined in units of information like that of a computer programme in 'bits', we can say that the invariant content of an organism, no matter how primitive or how complex, "is equal to the amount of information which, transmitted from one generation to the next, assures the preservation of the specific structural standard."

Now this property of reproductive invariance, that is, reproduction without gain or loss of information required to build it, incorporated in the genetic structure we nowadays call DNA, may be the outcome of chance. For it is "essentially unpredictable". But once arisen, it will enable the macromolecule to mechanically and faithfully replicate itself almost *ad infinitum*. The upshot then is its explosive growth into millions and billions of copies. We see this explosive growth continually at work in all organisms from cultures of lowly bacilli to human populations. Thus the parental macromolecule may be the outcome of chance but not its subsequent multiplication. As Monod says, "Drawn out of the realm of pure chance, the accident enters into that of necessity, of the most implacable certainties".

If I may abbreviate Monod's argument in *Chance and Necessity* in the form of an allegory, it is as follows: Your chance of winning a lottery may be infinitesimal. But if it is not zero, that is, otherwise impossible, you are bound to win some time or other, provided you have quasi-infinite time and equally ample resource to continue the game. Further, once you have made your first million in a lottery, its subsequent multiplication into more millions and billions is no problem. They come almost automatically and all but effortlessly! Likewise, the first self-replicating macromolecule of life—the analogue of the first million—may arise by chance and the chance may well be very small. But given four billion years of earth's existence and its environmental resources, even a small chance will produce macromolecules endowed with the property of reproductive invariance. As Monod says, "Even today a good many distinguished minds seem unable to accept, or even to understand, that from a source of noise natural selection, alone and unaided, could

Did life originate in space?

DID life originate in the interstellar space—in the cosmic dust clouds? Such a possibility was first conceived almost a hundred years ago by the famous Swedish chemist S. Arrhenius and others. Various known as the theory of Cosmozoa or Panspermia, the concept postulated the transfer of small particles including spores of microorganisms through interstellar and interplanetary space. But later such an idea seemed improbable and was soon forgotten. The primordial seas and oceans of our planet were considered an ideal cradle for the origin of life. A.I. Oparin's (USSR) thesis and Stanley Miller's (U.S.A.) historic experiments with simulated primitive terrestrial atmosphere gave credence to the chemical evolution theory. But they could not go far in explaining the coming into being of the first living cell.

Of late, the spotlight has again turned on the extraterrestrial origin theory, this time with the British astrophysicist Fred Hoyle as its chief proponent. Hoyle and his associate N. Chandra Wickramasinghe base their arguments on the discovery of complex organic molecules in space.

Over the past decade, radio-astronomical observation of prestellar clouds have shown the existence of a rich variety of organic molecules. More than 40 of them have been identified so far including the polysaccharide, cellulose (see page 641).

Hoyle and Wickramasinghe believe that prebiotic biological systems could have evolved from such molecules under interstellar conditions and carried to earth by cometary dust, meteoroids and meteoritic particles. A strong evidence of possible link between interstellar dust, meteorites and the transport of life to earth comes from recent spectroscopic studies of extracts of organic materials from meteorites. Some earlier reports even claimed identification of microfossils in meteorite fragments. In a recent experiment the infrared spectra of insoluble organic material from meteorite was found to be identical with those of pollen-like spores in Pre-Cambrian sediments on earth. May be, these spore-like primitive interstellar 'protocells' were the precursor of all life on our 'living' planet.

B. B.

have drawn all the music of the biosphere. In effect, natural selection operates upon the products of chance and can feed nowhere else; but it operates in a domain of very demanding conditions, and from this domain chance is barred. It is not chance but to these conditions that evolution owes its generally progressive course, its successive conquests, and the impression it gives of a smooth and steady unfolding".

Although the main thrust of Monod's argument seems incontrovertible, it has recently been challenged by another of his countrymen, E. Schoffeniels. In his book *Anti-*

Chance, Schoffeniels claims to subvert Monod's arguments completely. In fact, the subtitle of the book itself is called "A Reply to Monod's *Chance and Necessity*" to highlight its basic theme. He is provoked to make the "reply" because in his opinion Monod's thesis of biological evolution is based on obsolete biological ideas inherited by him from nineteenth century biologists like Darwin and Lamarck. As he says, Monod's book "is a very elegant tableau of nineteenth century biology seasoned with several piquant spices which ornament the biochemists' shelves. And this is a pity because, with a brilliant past as a researcher,

who better accredited in France than Monod can present a truly modern view of biology with its realities and hopes?

"On the contrary, in a vigorous well-muscled and minutely detailed style, the author proposes certitude which appease the anguish of our contemporaries..... Monod's book is deceiving because it leaves the reader eager. With an eloquent style which borders on the pathetic and which certainly would not be abjured by our great romantics, the argument unfolds according to an extremely simple logic. The concepts of chance and necessity, central themes of the work, are always far from adequately analyzed. And it is here that confusion and ambiguity arise. One comes away from reading the work frustrated since one knows not whether, in the mind of Jaques Monod, life is the result of coincidence of diverse independent chains of causality or, on the contrary, whether it obeys the more fundamental concepts of chance as proposed by the Danish school of physicists. Lastly, problems of evolution and finality in biology are juggled in consoling reference to largely diffuse and yet quite debatable ideas formulated since the beginning of this century".

I had read Monod's *Chance and Necessity* when it was first published several years ago. On reading Schoffeniels *Reply to Monod* I re-read Monod's book to see if Schoffeniel's critique has any validity. Unfortunately for him, I still prefer to remain a "great romantic" with Monod rather than a dull and pedestrian "realist" with Schoffeniels. It is not Monod's book that is "deceiving" but rather Schoffeniel's reply. If Monod's book invokes chance to explain the transformation of species by the interplay of mutation and natural selection, this cannot be regarded as its demerit simply be-

(Continued on page 658)

BEFORE YOU MARRY GO TO A GENETIC COUNCELLOR

There are more than 2000 known genetic disorders of man. Many of them can be prevented by proper genetic counselling

THE phenomenal increase in our knowledge of the basis of genetic diseases and the development of reliable diagnostic methods during the past 50 years, especially in the developed countries, has seen a steady decline in infant mortality from these diseases. However, this rapid expansion in our knowledge about genetic diseases has not been accompanied by concomitant development in transmission of this information to the affected families. Today, almost 2000 genetic disorders are known, some are harmless, while many others are severely handicapping and result in physical, emotional and financial burdens on individuals, their families and society. There are many disorders not based on simple genetic mechanisms, but are significantly more frequent amongst the

close relatives of affected persons than in the general population. Large scale surveys enable empirical risk figures to be established, so that families can be given suitable advice. When this advice relates to the possibility of a particular genetic disorder in future children and other family members, it is known as 'Genetic counselling'.

Genetic counselling is the most immediate and practical service that genetics—the science of hereditary transmission of traits from parents to their offsprings—can render in medicine and surgery. Despite an increase in our knowledge of the genetic code, much of genetic counselling is still concerned with statistical risk estimates of having an abnormal child. Recent advances in medicine and genetics, like antenatal diagnosis by

means of amniocentesis, help the genetic counsellor in giving the parents exact information as to the status of their unborn child in regard to any genetic disorders. Genetic counselling is best done by individuals trained especially in chromosomal and biochemical genetics. It allows prenatal and early postnatal detection of affected individuals and of carriers of defective genes. Early identification allows appropriate therapeutic measures, thus minimizing later pathological conditions.

The conception of a child within the mother's womb takes place when a sperm from man—containing 23 chromosomes—unites with the ovum from woman which too contains 23 chromosomes. But if a sperm with a chromosome complement other than 23 (22 or 24) unites

P. K. SETH

S. SETH

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with an ovum with 23 chromosomes, the resulting zygote will develop into an abnormal child. Likewise, if a sperm with 23 chromosomes unites with an ovum containing a haploid set of chromosomes other than 23, then also it would result in a zygote leading to an abnormal child. Normally, any deviation in the process of fertilization of an ovum leads to the development of an abnormal fetus resulting in spontaneous abortion or still-birth. But if the child is born alive, it would be abnormal.

Pregnancy in women above the age of 30 years often results in the birth of a mongol child (Table 1). Another condition often found with children of mothers above 30 is 'Trisomy 21.' Increase in maternal age possibly leads to failure of a pair of chromosomes to separate during division of the sex cell (oocytes). The age of the father, however, has no such implications. The reason for this is that the spermatozoa are produced in a male throughout his life, whereas oocytes are produced in a female quite early in life and then remain in the ovary till about 50 years of age. Mothers beyond 30 years of age, therefore, must seek genetic counselling before going in for more children, especially if they had an abnormal child earlier.

Genetic counselling can enable parents to avoid the risk of having a deformed child. For example, if prenatal examinations reveal a genetically damaged or deformed fetus, the parents may then decide to terminate the pregnancy. If the tests give normal results, the parents could then look forward to the birth of a healthy child. Of course, for complete success of the method, continued but carefully controlled studies of the precise risks to the mother and the fetus are essential.

The possibility of giving useful genetic advice has increased in

Table 1

Maternal age	Risk of occurrence of birth of a 'mongol'	Risk of recurrence of birth of a 'mongol'
20—30	1 : 1500	1 : 500
30—35	1 : 750	1 : 250
35—40	1 : 600	1 : 200
40—45	1 : 300	1 : 100
45 upwards	1 : 60	1 : 20

Table 2. Rh compatibility (—) and incompatibility (+) combinations between parents and the baby

Father	Mother	Fetus/baby	Rh haemolytic disease
Rh —	Rh —	Rh —	—
Rh —	Rh +	Rh — or Rh +	—
Rh +	Rh +	Rh — or Rh +	—
Rh +	Rh —	Rh +	+
Rh +	Rh —	Rh —	—

recent years as techniques for rapid, safe and accurate diagnosis of genetic defects are being integrated into the practice of medicine, almost as rapidly as they are being developed. In this progress, biochemical and cytogenetical advances have played an extremely important role. As many of the biochemical disorders have a common clinical, phenotypic intellectual impairment (similar morphological and behavioural symptoms), simple and practical methods utilising microorganisms have been developed for mass screening. Bacterial inhibition assays are widely used in the screening programs for the detection of amino acid disorders.

There is general agreement that screening for genetic disorders like phenylketonuria, galactosaemia and fructosaemia among new born infants is beneficial because early detection and treatment contribute significantly to the health and well-being of the children with these disorders.

Of the genetic diseases that can be detected in newborn screening surveys using dried blood specimens, phenylketonuria, homocystinuria and histidinemia are not associated with symptoms appearing early in life. On the other hand, Maple syrup urine disease, hereditary tyrosinemia and

galactosaemia are life threatening conditions with symptoms appearing early in life.

Erythroblastosis foetalis, a disease called hemolytic anemia of the fetus or a newborn infant (commonly known as +ve or —ve blood or rhesus factor), occurs when Rh-antibodies present in the mother's circulation cross the placental barrier and damage the foetal red cells by agglutination (clumping together) of the erythrocytes (red blood corpuscles). This Rh-haemolytic disease can be controlled by treating the affected infant. But recent advances in immunology have provided means of effective prevention.

The entry of foetal red cells into the maternal circulation occurs during labour and placental separation. Most sensitisation, i.e., production of Rh antibodies, therefore, occurs about that time. That is why the Rh +ve child is usually unaffected. It has also been noted that if the Rh +ve fetus has an ABO blood group incompatible with that of the mother, the likelihood of Rh immunization occurring is much diminished. This could possibly be due to naturally occurring anti-A or anti-B in the maternal plasma which destroys the foetal red cells of the appropriate blood group.

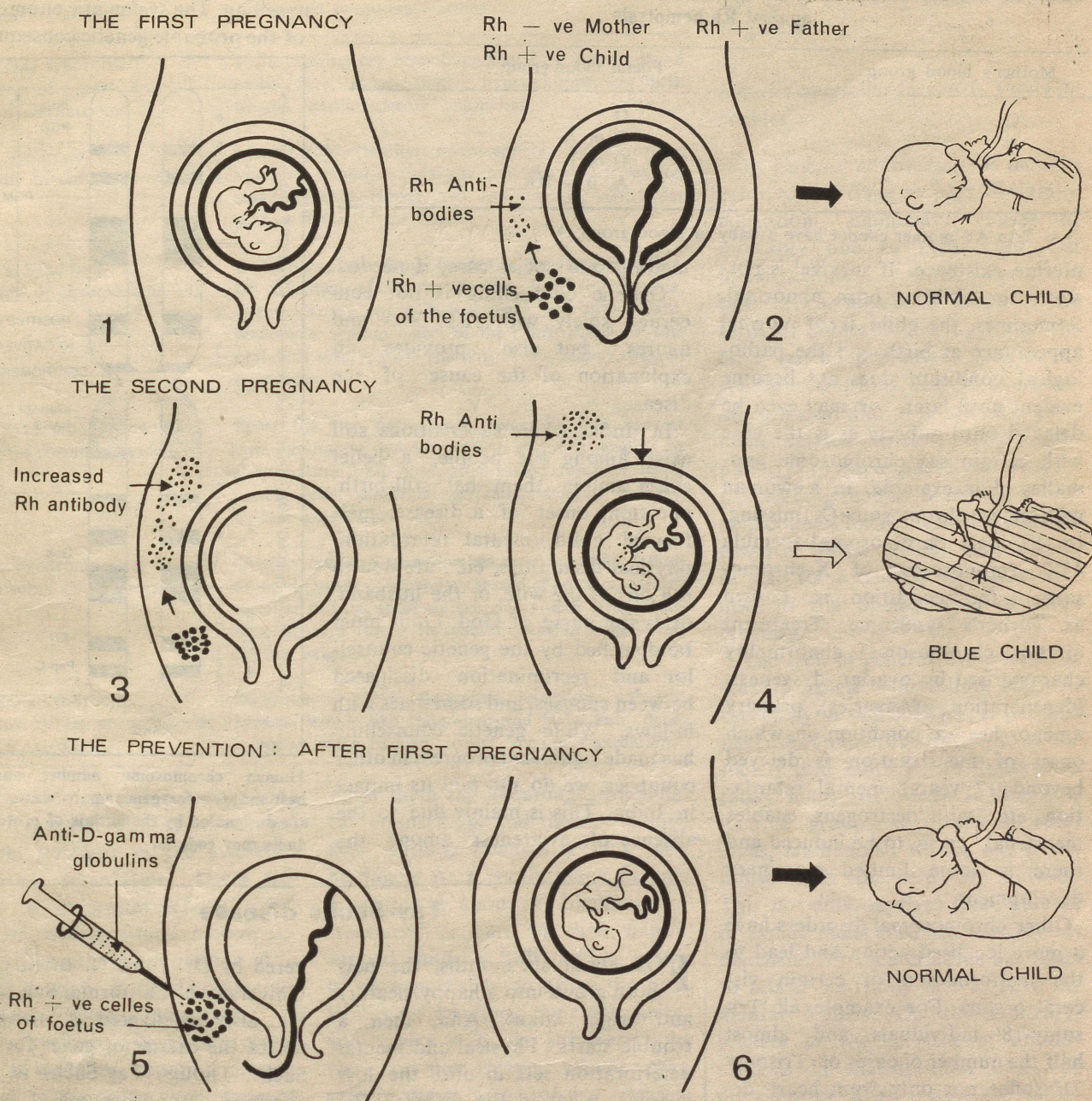


Fig. 1. Cause and prevention of erythroblastosis foetalis. Placenta is expelled at birth of an infant and the Rh + ve fetal cells leak into the maternal circulation and produce Rh antibodies (2). Rh + ve cells disappear from the mother's circulation but the Rh antibodies remain for many years (3). All future Rh + ve babies will be affected (4). Intramuscular injection of anti-O gamma globulin (Rh antibodies) within 72 hours of delivery eliminate Rh + ve fetal red cells from the mother's circulation (5) thereby suppressing immunisation (sensitisation) (6) and birth of a healthy child

Genetic counselling has rapidly changed from a simple presentation of a Mendelian probability to the identification of high risk marriages. More recently identification techniques, such as fluorescence (emission of radiation as a result of

exposure to UV light using different dyes) and heat treatment (technique for producing banded segments along the chromosomes to facilitate their identification), have enabled genetics to elicit considerably more data from chromosomal ex-

amination. Some of these disorders, which are incompatible with embryonic or foetal survival, cause intra-uterine death of the infant. Thus, a large number of spontaneous abortions are the result of chromosomal anomalies incompatible with extra-

Table 3. Combinations of ABO blood groups which do not afford protection against Rh hemolysis

Mother's blood group	Foetal blood group
O	O
A	O or A
B	O or B
AB*	A, B or AB

*An AB mother cannot have a baby of blood group O

uterine existence. If survival is possible, the child is born abnormal. Sometimes, the child is of normal appearance at birth and the pathological condition does not become evident until later, or may even be delayed until puberty as is the case with certain sex chromosome anomalies. For example, in a woman with one sex chromosome (X) missing, i.e., having a chromosomal formula 45X (monosomy of X-chromosome), the condition is known as Turner's syndrome. Treatment of this chromosomal abnormality characterised by ovarian dysgenesis (degeneration of ovaries), primary amenorrhea (a condition in which onset of menstruation is delayed beyond 17 years), mental retardation, etc., with oestrogens enables menstrual cycle to be induced and there is some limited mammary development.

Other chromosomal disorders have a more localised action and lead to the malformation of certain visceral organs. For example, all 'Trisomy-18' individuals and almost half the number of cases of 'Trisomy 21' suffer not only from heart defects but have facial deformities, mental and motor retardations etc.

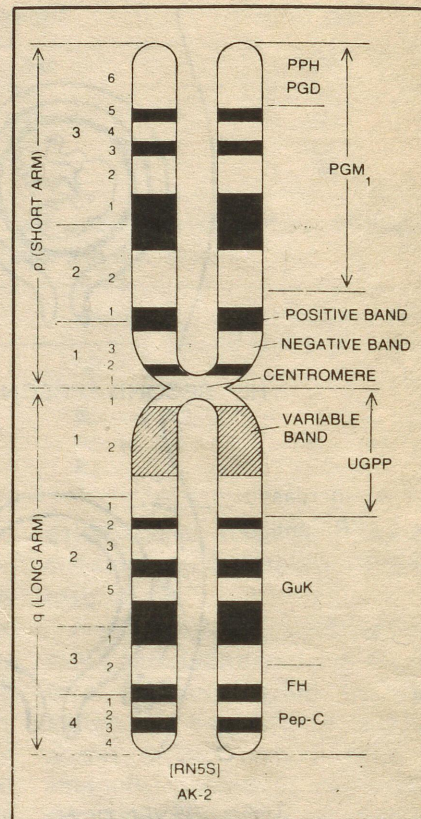
Although these chromosomal disorders are not amenable to treatment, their detection in a family helps the genetic counsellor to estimate the risk of recurrence of the abnormality in future children. Parents thus informed can plan their families accordingly. If the parents decide to have another child, fully aware of the risks involved, they can prepare for the proper

medical and social care, if needed.

Genetic counselling is not concerned solely with risk facts and figures, but also provides an explanation of the cause of the disease.

In India, where superstitions still exist among the people, a belief exists among them that still-birth, abortion, onset of a disease, malformed child, mental retardation, physical disabilities, etc., are due to the sins of the wife, or the husband, or is the curse of God: Guilt must be dispelled by the genetic counsellor and recrimination dissipated between spouses, and sometimes with in-laws. While genetic counselling has made significant progress in other countries, we do not find its impact in India. This is mainly due to the absence of awareness among the

people about the utility of genetic counselling. The systematic enumeration of the probable genetic consequences



Human chromosome number one, the best mapped for genes up to date. Genes are designated by the initials of protein products they code for

Tay-Sachs disease

FOR about six months, the new born grows into a happy, healthy and bright infant. And, then, a trouble starts: Physical and mental deterioration sets in until the loss is total. What is the disease? The doctor diagnoses it as Tay-Sachs.

Tay-Sachs is an inheritable disease caused by the lack of a gene-coded enzyme that normally controls harmful accumulation of fat around cells of the nervous system. The absence of the enzyme is, however, inevitable when a child inherits from each parent a recessive gene which permits fat accumulation. The enzyme that prevents against fat deposition was disco-

vered by Dr. John O. Brien of the University of California, San Diego. He also discovered a means to detect the carrier of genes for Tay-Sachs. Though Tay-Sachs is most common among persons of eastern European Jewish heritage, the disease is present in other races too.

Since parents carrying a recessive gene for Tay-Sachs are more likely to produce a disease afflicted child, genetic counselling and timely testing of amniotic fluid surrounding the fetus can help detect such a defect. In case the tests are positive one should, logically, prefer abortion to a malformed baby!

Z.I.

Table 4. Some chromosomal abnormalities and associated features

Chromosomal anomaly	Associated symptoms/features
Cri-du-Chat syndrome (deletion of a part of small arm of chromosome 5)	Faint mewling cry resembling that of a kitten, round moon face, microcephaly, hypertelorism, low birth weight, cardiovascular anomalies.
Patau's Syndrome (trisomy of chromosome 13)	Mental subnormality, microcephaly, hypertelorism, low birth weight, polydactyly, hairlip and cleft palate, small mandible (lower jaw), low set ears, ventricular septum defect of the heart.
Edward's Syndrome (trisomy of chromosome 18)	Dolich-occephaly (long headed), hypertelorism, low set deformed ears, micrognathia and retrognathia, camptodactyly, rocker bottom foot, low birth weight, ventricular septum defect of the heart, defect of one umbilical artery, malformation of the kidney, mental retardation.
Down's syndrome (Mongolism) (trisomy of chromosome 21)	Broad flat face, flat occiput, epicanthic fold, low set ears, hypotonia, deficient growth of limbs leading to short stature, snub nose, often malocclusion of teeth, double chin, abnormal genitalia, delayed puberty, mental retardation.
Turner's Syndrome (monosomy of X-chromosome)	Ovarian dysgenesis, amenorrhea, total infertility, failure of development of secondary sexual characters, cardiovascular defects, short stature, short neck with webbing of skin (loose redundant skin) of either side, cubitus valgus.
Klinefelter's syndrome (trisomy of sex chromosomes —XXY condition)	Seminiferous tubule dysgenesis, infertility, enlarged breasts, female like abdominal and facial hair development, eunuchoidism, overt mental retardation.

of population control include among others a lower frequency of mongol children, decrease in the incidence of mental retardation, lower frequency of congenital defects, fewer cases of maternal-fetal incompatibility (like Rhesus factor) and a relative decline in consanguineous marriages (cousin marriage).

Our experience with genetic counselling is quite encouraging though not as dramatic as the experiences of fellow colleagues in other countries. For instance, among the 120 odd families approached by our group through the special schools for the mentally subnormal, 80 parents agreed to cooperate in our study, 20 had a negative response, and the rest preferred not to respond at all. During the course of personal meetings with the parents we were able to dispel their doubts, impress

upon them the advantages of genetic counselling, and thereby change their outlook towards seeking such guidance. As a result, many parents consulted us about the likelihood of treatment or cure of their handicapped children. Still another group of parents wished to know the possibility of marrying their daughters, who were mentally subnormal, in view of the greater sexual urge seen in them. Much of our counselling, while certainly contributing to the understanding, acceptance, and control of genetic disease, did produce favourable results.

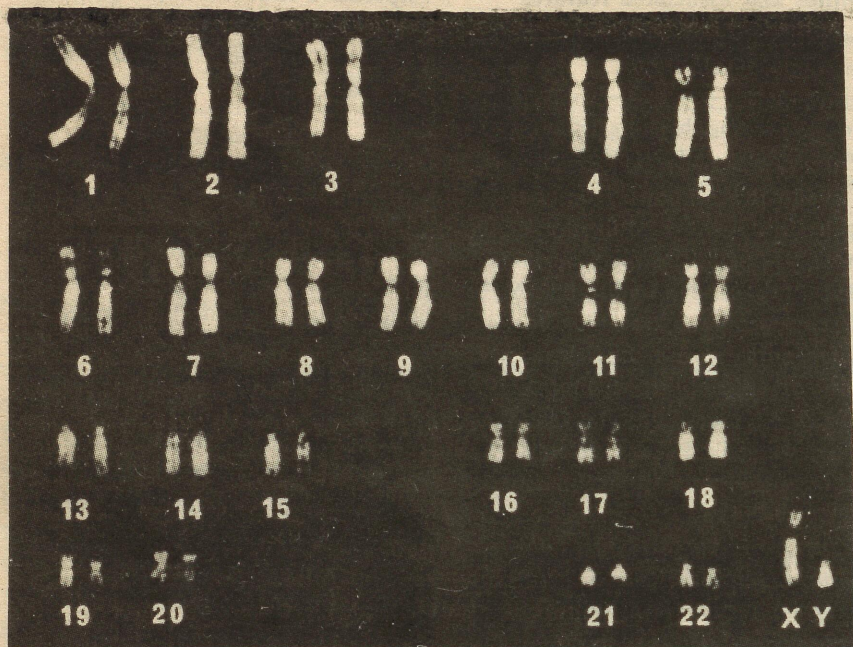
Genetic counselling should always be imparted by a team of experts. The results in a complicated case should always be communicated to the prospective seeker by the family physician or some other individual best qualified for the task. It is

imperative that a human geneticist, with extensive training, should form the core of every genetic counselling team.

Genetic counsellor to match 'would-be couples'

If genetic counselling is sought prior to marriage as part of family education, immediate causes of mortality due to ABO and Rh incompatibility, anemia, malnutrition, miscarriages, still-births or the birth of babies with congenital defects, can be prevented. Such counselling would also help in overcoming physical and psychological problems related to the period from puberty to menopause in women. Counselling before marriage would help couples form a scientific attitude towards sexual needs and desires as also for a healthy sexual awareness to the phenomenon of procreation.

The lack of general awareness for seeking genetic counselling services, especially in our country, is perhaps because of numerous restraints of our society and culture. In India even today many deliveries in the low income groups, especially in rural areas, are handled within one's own house with the help of midwife. This not only deprives these parents of expert medical advice and services beneficial for their children but leads to infant mortality due to environmental factors. On the contrary, seekers of the services of amniocentesis in metropolitan cities of our country often misuse the information of such genetic counselling in deciding in favour of a particular sex of the child ! This should be strongly discouraged by the genetic counsellor. In the interest of the population at large, such counselling centres should be established in regions where infectious diseases and nutritional disorders are under control and the relative importance of hereditary



Human chromosomes

Some 200 genes in human chromosomes mapped

MUCH progress has recently been made in genetic mapping of the location of at least one gene on each of human chromosomes. Altogether, about 210 human genes have been mapped and assigned locations on one or other chromosome. In man, the specific chromosome that carries each of about 210 gene loci is now known. These loci include at least one assigned to each chromosome (including the Y), about 110 assigned to specific autosome, and about 100 to the X chromosome. For many loci, information on regional chromosomal localization is also available. Although some of these locations have been known for a long time, more than half the assignments have been made within the last five years. Five years ago, 86 gene locations were known on the X chromosome. The number known on the non-sex chromosomes was under 10. Though some of the fine detail is now

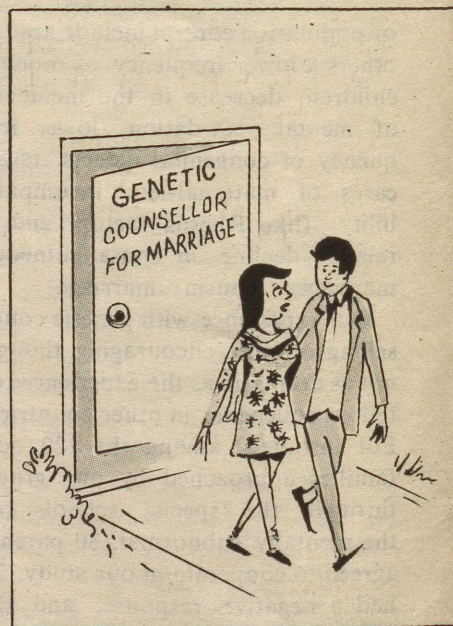
coming into light, most of human chromosomes is still unmapped territory. The total number of human genes determining all manners of hereditary traits is estimated at 50,000. For 1,000 of these, there are some clues as to the group of chromosomes on which they are located, but that is all. Mapping of human genes is important for understanding evolution, the nature of some cancers and birth defects and potentially for diagnosis of serious disease while a baby is still in the womb. Recently, Drs. Victor A. McKusick of Johns Hopkins University and Frank H. Ruddle of Yale University summarized advances in gene mapping made by scientists throughout the world (*Science*, 196, 390, 1977). The mapping information came mainly from studies in families and somatic cell hybrids, as well as a combination of results from the two methods.

B. D.

disorders is increasing, and in areas where genetic disorders have always constituted a serious public health problem. Very special considerations apply to areas with high frequency of sickle cell anemia and thalassaemia (a genetically determined defect of hemoglobin synthesis) as they require a special genetic counselling for carriers as well as suitable medical facilities for the care of afflicted individuals.

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"He advised me not to marry you, as you are a genetically eroded man. What does it mean, any way?"

THE WORLD OF NEUTRONS

Neutrons can be put to a variety of uses

SURESH GARG

NARESH KUMAR

NEURONS, which form one of the two building blocks of atomic nuclei, were discovered in 1932 by the English physicist James Chadwick. A whole field of research "Neutron physics", based on their properties, has come into being now.

Our ideas of nuclear structure have also crystallized due to them. Besides, their vital role in the liberation of energy from matter through a nucleus fission reaction (both for peaceful and destructive purposes) is well-known.

Discovery

The existence of a neutron as a composite particle (of a proton and an electron) was first postulated in 1920 by Ernest Rutherford (U.K.) in a lecture given before the Royal

Society. The need for this was to circumvent certain difficulties associated with the structure of atomic nuclei. The real existence of these particles was, however, demonstrated only in 1932 by Chadwick through the bombardment of beryllium nuclei with alpha particles (nuclei of helium atoms). As their very name indicates, they are neutral particles having no charge. Their mass (1.67×10^{-24} g) is only slightly greater than that of protons, their co-mates within the nucleus of an atom. They, along with protons, are collectively called nucleons.

Before the discovery of neutrons, it was believed that atomic nuclei contain electrons and protons. Heisenberg's uncertainty principle was clearly opposed to the presence of electrons within nuclei. The discovery of neutrons, however, gave support to the uncertainty principle,

removed certain ambiguities in nuclear structure data, and gave a new direction to further research.

Neutrons, like most other fundamental particles, have their anti-particles called anti-neutrons. Neutrons and anti-neutrons differ only in their magnetic moments; the magnetic moment of one being the opposite (in sign) of the other. When a neutron and its anti-particle combine, they annihilate each other.

Structure

As against the general belief, neutrons may have an inner structure of their own. Clues to this structure are provided by their radioactive nature and their coexistence with positively charged protons within atomic nuclei.

Neutrons are bound in nuclei through very strong, short-ranged

and attractive forces called nuclear forces. To explain the presence of these forces, it is believed that all nucleons continually keep on emitting and re-absorbing some light particles called π -mesons. All nucleons may thus be supposed to have at all times a cloud of mesons around their central core.

Once free, a neutron radioactively decays into a proton, an electron and an anti-neutrino with a half-life of about 12 minutes. Very crudely a proton may then be visualised to form the central core in a neutron and the electron-neutrino pair may be thought to originate from the meson cloud surrounding the proton core. This picture of the structure of a neutron is supported by the observation of a magnetic moment (-1.91 nuclear magnetons) for the neutron, as well as by the decay of 'free' charged π -mesons into electrons and neutrinos.

Various experiments (electron-neutron scattering) conducted to explore further the structure of the neutron have, however, discounted the above picture. They seem to suggest that there is no central positive core in a neutron as distinct from a negative π -meson cloud. Instead, they suggest that a neutron is electrically neutral throughout its volume.

Classification

Most of the spectacular uses of neutrons are because of their lack of charge. Being so, they enter almost unhindered (without the effect of any electric and magnetic field) in any material whatsoever. They, however, do lose some energy in each atomic collision and sometimes come to a stop in a head-on collision with an atomic nucleus.

Neutrons in their interaction with matter behave both as particles and waves (de Broglie hypothesis.). At slow speeds they lose their particle characteristics and behave as waves.

Table 1. Classification of neutrons according to energy

Category	Energy range
Fast neutrons	$> 1 \text{ KeV}$
Slow neutrons	$< 1 \text{ KeV}$
Thermal neutrons	$0.15 = 0.005 \text{ eV}$
Cold neutrons	$0.005 = 0.001 \text{ eV}$
Ultra-cold neutrons	$< 0.001 \text{ eV}$

*1 KeV = 10^3 (electron volt); 1 eV = 1.6×10^{13} erg

The slower is their speed, the greater is their wavelength. The utility and character of neutrons thus change tremendously with their speed. In

general, the wavelength of the associated de Broglie waves needs to be of the same order of magnitude as, say, the spacings between atoms in a

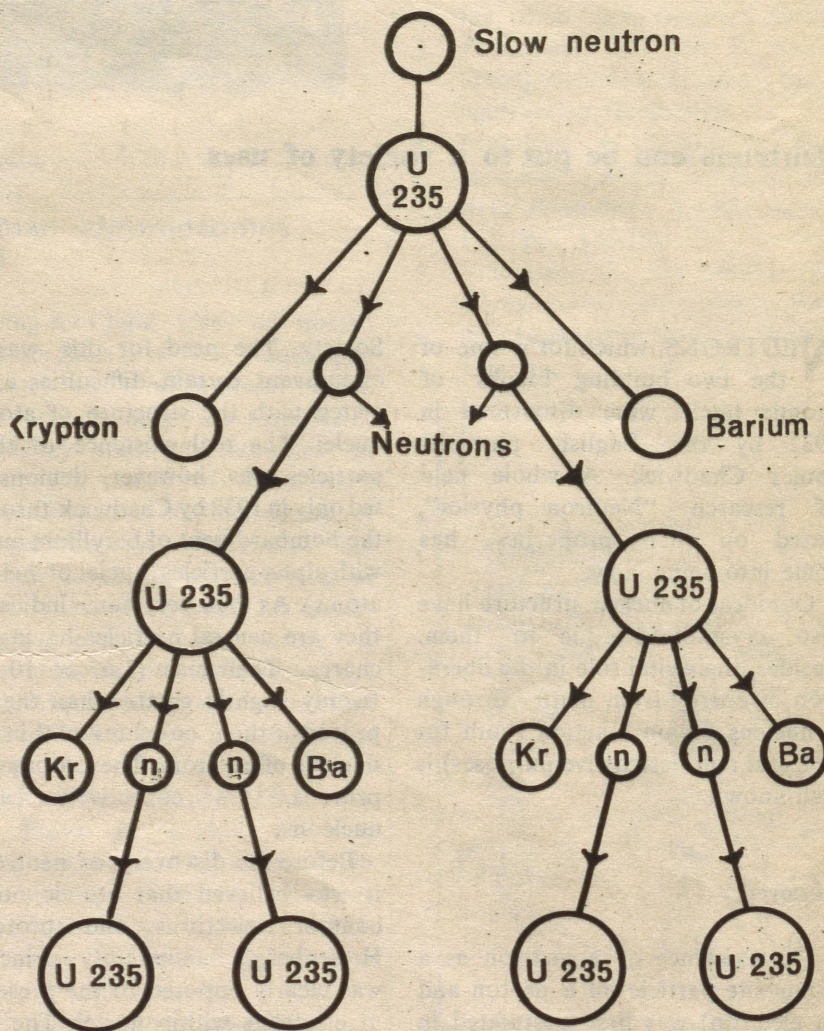


Fig-1 Neutron induced chain reaction

Neutron bomb

INFORMATION on the mechanism of neutron bomb, also called the neutron warhead, is highly classified. However, according to available reports, the neutron bomb is based on thermonuclear fusion of fuel such as hydrogen unlike the conventional hydrogen bomb in which the fusion reaction is activated by a nuclear fission reaction. The fusion reaction in a neutron bomb is probably ignited by a non-atomic fuel such as the TNT.

A neutron bomb, it is believed, emits an intense flux of high-energetic neutrons. These neutrons can destroy all living organisms by disrupting their cells. A neutron bomb, unlike the atom bomb, is reported to have the potential of killing people without causing any blast and heat damage to property.

It appears that miniaturization work on neutron bombs has been going on since early fifties, both in the U.S.A. and Russia. Now these

bombs are available even as 20 cm artillery shells.

A shield of 15cm thick concrete or 60 cm thick wood can absorb the emitted neutrons from these bombs. For unshielded troops on the war-front, neutrons from such a bomb may mean instant death.

There are, however, two puzzling factors in the reports available on the mechanism of such a bomb. It is not clear as to where the enormous amount of energy released in a fusion reaction goes. This energy should cause blast and heat-damage to buildings. Secondly, it is not apparent how a fusion reaction is achieved with a fuel like TNT, and that too in a device of such a small size, when scientists have so far failed to achieve thermonuclear fusion in a controlled way without an initiating fission reaction in a laboratory.

S. G.
N. K.

crystal whose properties are under investigation. As neutrons of any speed (or kinetic energy) can enter any material, usually their best speed for accomplishing a particular job is first chosen.

Neutrons for different tasks are classified (Table 1) according to their energy content. Two main categories are the 'slow' and the 'fast' neutrons. Most of the spectacular applications of neutrons result from the use of slow neutrons. It is because the slow neutrons have a larger probability of interaction with most materials than the fast neutrons.

Thermal neutrons constitute an important category of neutrons. They are the ones whose average kinetic energy is approximately equal to that of the atoms (or molecules) of

the medium in which they get scattered. The average speed of thermal neutrons is 2.2×10^5 cm/s. Fast neutrons of 1 MeV (10^6 eV) energy have a speed of 1.4×10^9 cm/s.

Neutrons are generally obtained from two sources. One is by exciting neutron-producing reactions, and the other as a by-product of a fission chain reaction in a nuclear reactor. Both these sources usually produce fast neutrons which are generally slowed down before use by passing them through a moderator such as heavy water.

Owing to lack of charge, neutrons do not interact appreciably with electrons. This does not allow them to cause appreciable ionisation in any material which eventually poses difficulties in their detection. They are therefore usually detected indirectly,

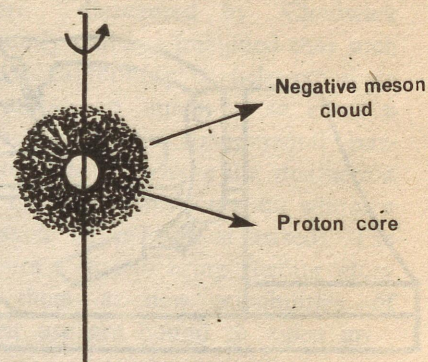


Fig. 2

from the ionisation of some charged particles which they release while interacting with some materials.

Applications

Neutrons are extensively used both in pure scientific research and in applied fields. Given below are the wide variety of ways in which they affect our lives.

Nuclear fission. Soon after their discovery, i.e., in 1939, neutrons found for themselves probably the most important use they have ever been put to. This was in the liberation of energy from matter through a nuclear fission chain reaction. The release of energy in such a reaction is governed by Einstein's mass-energy relationship ($E = \Delta m c^2$) and takes place when slow neutrons are bombarded on some fissionable material like uranium-235. This energy was used for destructive purposes in the form of atom bombs in the Second World War. Now this energy is being utilised on a very large scale for generation of electric power in nuclear reactors and for running of submarines in oceans.

Radioisotopes. Another significant use of neutrons is in the production of radioisotopes. Most of the radioisotopes available today are produced by the bombardment of

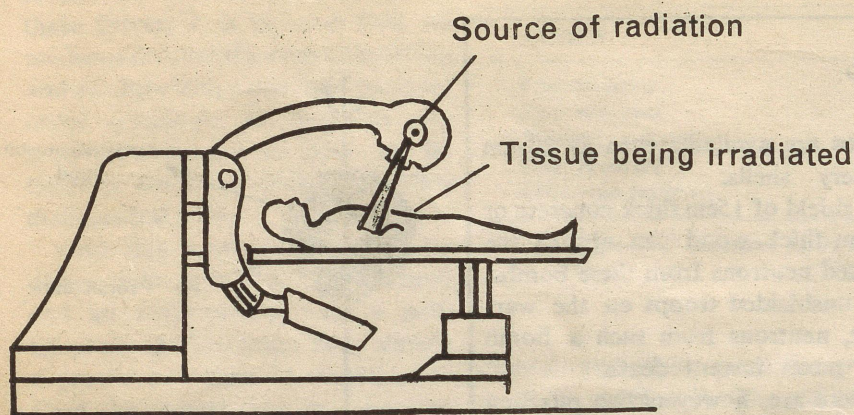


Fig. 3

naturally occurring isotopes with neutrons generated in a nuclear reactor. Radioisotopes have innumerable uses in almost all branches of science. Their contribution in the therapy of some lethal diseases such as cancer is well-known. Their utility as 'tracers' in scientific research is of great value.

Nuclear research. Neutrons have played a significant role in nuclear research. Proton-neutron scattering experiments, have been used to infer basic nuclear force between nucleons within the nuclei. From certain reaction the properties of nuclear levels are deduced, which in turn provide information on the structure of atomic nuclei. Further, neutron bombardments of heavy nuclei have been used to form transuranic elements, i.e., elements with atomic number greater than 92.

Neutron therapy. In advanced countries, fast-neutron beams are now also being used for therapeutic work. Their potential in curing diseased tissues, say, those of cancer, is receiving the attention of medical personnel the world over. This is because they cause less damage to the tissues than other forms of radiation.

Activation analysis. Neutron activation analysis with both slow and fast neutrons is used for determining the elemental and/or isotopic

composition of materials. In this, the relevant material is exposed to a beam of neutrons and the residual radioactivity (on the reaction product) is measured. An important feature of this analysis is that it is relatively very fast, and as such is suitable for industrial control problems. Some applications of this technique are in copper ore sorting, analysis of coal, and in measurement of salt and sulphur in crude oil.

Breeder reactors. One of the later uses of neutrons is in breeder reactors which produce more fuel (fissionable material) than they consume. These reactors generally use plutonium-239 as fuel which is covered with uranium-238 as a blanket. Fast neutrons liberated from

fission of plutonium-239 convert the surrounding uranium-238 into more plutonium than actually consumed. Such reactors promise an unending supply of nuclear power for the generation of electricity. With the depletion of fossil fuels (coal, natural gas, etc.), these reactors are our long term hope for meeting future energy demands.

Neutron radiography. Neutron beams are also used for non-destructive testing of heavy and complicated parts of machinery by taking their photographs with neutrons. This technique is highly sensitive

Neutron stars

ORDINARY stars (with mass >1.4 times the solar mass) in their evolutionary stage sometimes end up as neutron stars. These stars having a diameter of about 10 km to 20 km are composed mainly of very densely packed neutrons (about 80% neutrons, 10% protons and 10% electrons). The density of their constituent matter is about 10^{14} gm/cc. Density of the heaviest known element on earth is only 21 gm/cc.

During the contraction stage of a star when its density is around 10^{10} gm/cc, a process of inverse β -decay sets in. In this process electrons combine with protons to form neutrons and neutrinos. This is responsible for most of the neutron content of neutron stars.

Neutron stars rotate at very high speeds (usually several rotations/sec). They have very strong magnetic fields of the order of 10^{12} gauss. We receive electromagnetic pulses from them at extremely regular intervals of time (ranging from 0.033 to 4.0 for different stars). They are therefore also called 'pulsars' or pulsating stars.

It is believed that neutron stars, like the sun and most other stars, are subject to some violent surface storms spraying particles and radiation into space. Each storm occurs in a localised area on the star and sprays out radiation in a narrowly defined direction. When our earth lies in the path of that radiation, our radio telescopes pick up their signals. As neutron stars are believed to spin around their axes, the signal is received only once in each rotation. This appears to be the explanation for the regular time interval between the successive pulses which we receive.

S.G.
K.K.

for the detection of manufacturing defects like those in welding and casting of components.

Hydrogen bomb. An important use of neutrons, though quite an unpleasant one, is in the mechanism of hydrogen bomb. This bomb is based on the conversion of thermonuclear fusion of hydrogen nuclei into helium gas. Thermonuclear fusion in such a bomb is ignited by a fission chain reaction which in turn is initiated by slow neutrons. In short, slow neutrons act as a basic tool for activating a hydrogen bomb.

Astrophysical problems. Neutrons capture reactions conducted on earth are proving useful in understanding astrophysical problems connected with heavy element production in stars.

Solid state physics. Neutrons have proved very useful in investigating the properties of materials as well as liquids. Slow neutrons scattering experiments have been used to infer crystal structures and vibrations of atoms in crystals. For investigating relationships of

physical properties with atomic patterns in crystals, fast neutron scattering experiments have been conducted. These experiments have also been performed to change the properties, such as hardness and the ability to conduct heat and electricity, of metals. Slow neutrons are particularly useful in investigating crystal structures of hydrogenous compounds and magnetic properties of materials where X-ray studies completely fail. All these are of immense use in industrial problems.

Another important use of neutrons which is yet to prove successful is in the production of superheavy elements. These elements, only recently discovered, may be producible by a multiple-neutron capture process. In such a process the target nucleus increases its mass by capturing many neutrons and increases its atomic number by a process of continued β -decay. Such a process is known to occur in stars at the time of supernovae explosion.

From the above it is clear that the uses of neutrons are so varied and so many that we have to mention

them only briefly. When neutrons were discovered by Chadwick nobody perhaps imagined that such 'innocent looking' particles could accomplish so much in so short a time! Of all the fundamental particles neutrons have the distinction of being the only ones on whom a branch of physics is based. The future is sure to bring further glory to them—as new possibilities of their use are bound to open up.

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CORRIGENDUM

(i) In the article **Use of Transistor as a Switch** (*S.R.* September 77) there are following errors. On page 560, caption to Fig. 1. read $V=E$ for $V-E$; on page 561, first column, in 2nd paragraph, 7th line read $C_1=C_2=C$ for $C_1+C_2=C$; and in fourth paragraph, 10th line read $C_1=C_2=0.01\mu f$ for $C_1=C_2=0.01\mu$

(ii) The authors of the article **Of Pollen and Spores** (*Science for the Young* section, *S.R.*, September 1977) are Anup Kumar and Sunil Chaturvedi

(iii) In the article **Magic Squares** (*S.R.* July 77) there are following errors. On page 464, 2nd paragraph under "Definitions and formula" in 3rd line, omit % and read 1 for 1 and in line 5, omit %; page 465, 3rd paragraph under "Magic squares with desired constants", the first sentence should read as:

Thus, if M_B is the basic magic constant and M_D is the desired magic constant and N is the order of the square, then the starting number is $\{(M_D - M_B / N)\} + 1$

POWDER METALLURGY

P. RAMAKRISHNAN

Powder metallurgy offers a versatile technique for shaping powders of metals, alloys, ceramics and complex engineering products

THE production of metal components from powders is a unique technology. It is now used not only for metals but ceramics, polymers and a variety of composite materials as well. More and more materials engineers, production engineers and designers are turning towards powder metallurgy because the products can be made porous or dense as desired. They can be made with a much wider range of properties than cast and wrought products. What is more, these products can be made rapidly, automatically and more economically.

Traditionally powder metallurgy is used when conventional melting presents difficulties, when incompatible elements and systems have to be handled or when the machining costs and scrap losses have to be avoided. Metal powders are converted into useful products by com-

pacting them into the desired shape and size and sintering, sometimes followed by secondary operations. Many of the complex mechanisms that are responsible for transforming the metal powders to useful products of predetermined properties are not yet fully understood.

In recent years, the traditional powder metallurgy has undergone many changes. It is no more limited to relatively small parts that can be made with a punch and a die in a press. New techniques have been developed to manufacture larger and more complex parts. Powders can be directly rolled to produce strips and other flat products or can be extruded or forged to produce shaped objects with high strength properties. Today the technology is used for processing highly sophisticated materials with exceptional properties that are re-

quired for nuclear engineering, electronics and aerospace applications. The products which are successfully produced by powder metallurgy include porous self-lubricating bearings, filters, structural components, metal-carbon products, high temperature materials including dispersion strengthened alloys, magnetic materials including ferrites, cermets and other composites. There are several technical and economical benefits of processing high-speed steels, special alloy steels and super-alloys by powder metallurgy.

The process

Powders of required constituents and composition are blended to produce a mix, which is compacted to the desired size and shape and sintered in a furnace in a suitable atmosphere at a certain temperature

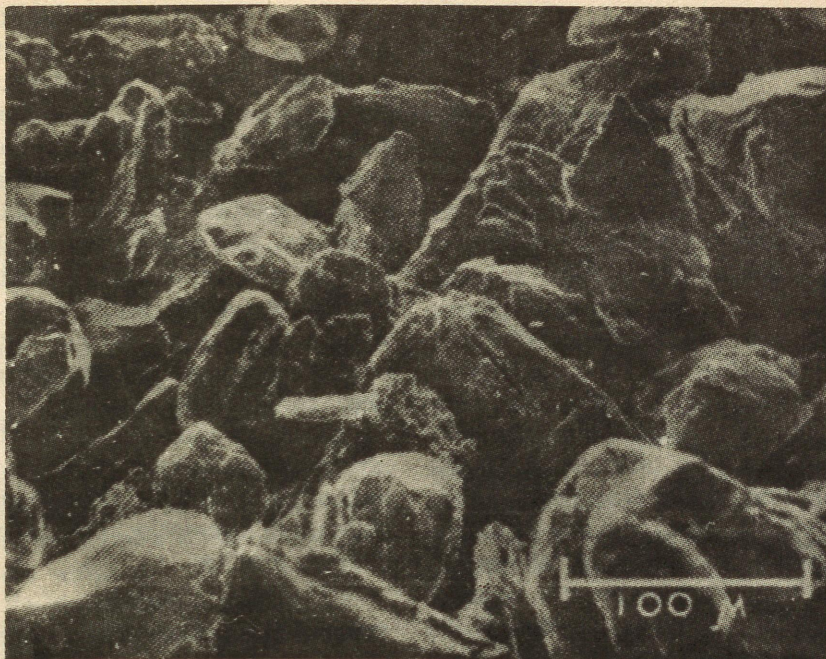


Fig. 1. Electron micrograph of electrolytic iron powder

for a definite time period. The sintered products are then subjected to secondary operations such as coining, impregnation or infiltration or are further compacted by rolling, extrusion or forging. Many of these products can also be heat treated to improve their properties.

Powders can be produced by atomisation of liquid metals and alloys, chemical reactions, electrolytic deposition or by mechanical processing of solid materials. Many of the metal powders, particularly iron, can be prepared directly from their ores or oxides by direct reduction with hydrogen, hydrocarbon gas or carbon. Several powders are produced by the electrolysis of aqueous or fused salt solutions. Powders of copper, nickel and cobalt can be produced by the pressure leaching of ammoniacal solutions of ore concentrate or scrap which offer an economical source of high purity powders.

For compaction, the powder blend is fed into a die and compressed in mechanical or hydraulic presses. The components for

compaction usually consist of die body, upper and lower punches and core rod, as shown in Fig. 2. First the upper punches are completely withdrawn from the die and the die cavity filled with the blended powder through a feeder. Then either the upper punches are brought down or the upper and lower punches

are simultaneously moved to compress the powder into the desired shape. The compacting pressure varies from a few tons to several tons depending upon the type of material and the density required. Subsequently, the top punches are withdrawn and the compacted part is ejected from the die. During compaction the porosity is reduced and density increases by powder particle movement, deformation and fracture. The bonding produced by cold pressing results from the mechanical interlocking and cold welding at the point of contact between particles. The simple die compaction has now undergone many developments. They include high energy rate forming, explosive forming, isostatic compaction, hot pressing, powder rolling, extrusion and forging.

The compacted parts are sintered by passing them through a furnace under a controlled or protective atmosphere maintained at a temperature below the melting point of the principal constituent. During sintering the metal powders are transformed into a mass in which the individual powder particles lose their identity. Subsequently, recovery, recrystallisation, grain

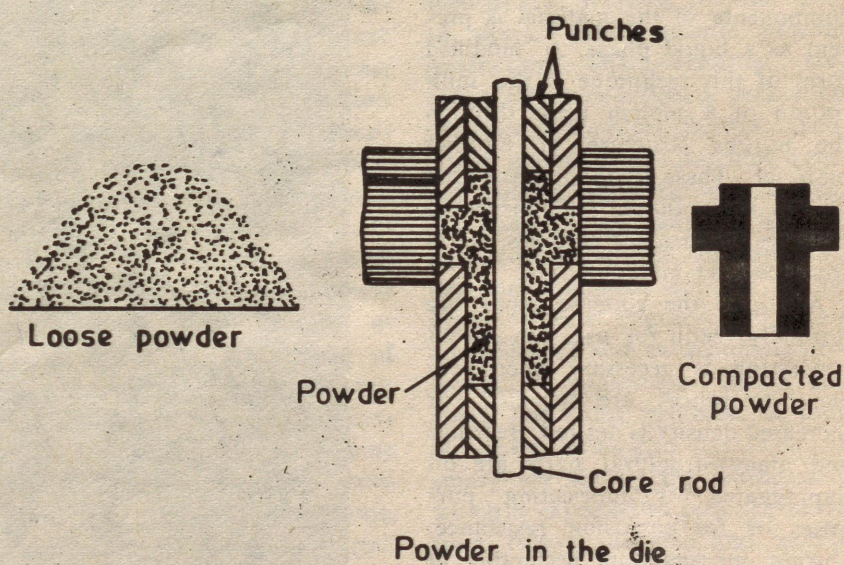


Fig. 2. Compaction process

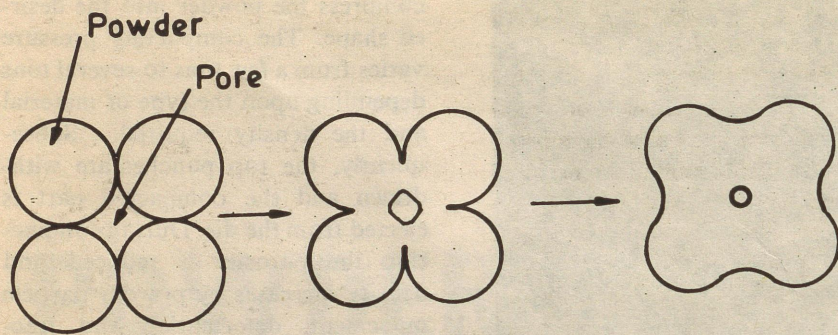


Fig. 3. Pore structure changes during sintering

growth, and alloying result in good bonding. The pore shape and size change as shown in Fig. 3. Sometimes transport mechanisms including various diffusion processes, creep deformation, evaporation and condensation also come into play during sintering. The mechanical properties of the compact is improved considerably through sintering.

In addition to the separate stages of compaction and sintering, it is possible to combine compaction and sintering by hot pressing. This technique is widely used for ceramics, refractory metals, special alloys and composites. In addition to solid state sintering, liquid phase sintering is also used in which one or more components of the material is present as a liquid phase. A modified form of this technique is the infiltration of a molten metal through the porous structure of another material. These techniques are used for the production of self lubricating bearings, cemented carbides, electrical contact materials, etc.

Although the sintered parts are normally ready for use, subsequent processing is necessary when very close tolerances are specified or increased density is desired. Bearings and many structural parts are oil impregnated for lubricating purposes or for corrosion resistance. During impregnation, preferably in vacuum, the sintered parts absorb oil readily because of their poro-

sity. The pores of powder metallurgy products can also be infiltrated with a metal or alloy of lower melting point. Generally the slugs of an infiltrant material are placed on the compacted parts and passed through the sintering furnace, when the infiltrant melts and penetrates into the pores. The mechanical properties are improved considerably because of the dense structure of the product.

Depending upon the requirements the parts can be subsequently coined, steam treated, rolled, extruded, for-

ged or heat treated to improve the properties. Many of the powder metallurgy products for advanced and high performance applications are processed to full density to take advantage of their superior mechanical properties. Normally in alloy formation the constituents exhibit a strong tendency to segregate during solidification which leads to local variations in composition and structure. But in powder metallurgy, since each powder particle is an alloy, the products are free from segregation and result in improved mechanical properties than the corresponding conventional cast and wrought products.

Developments in our country

Powder metallurgy industry is still in its infancy in our country. Production of powder metallurgy products such as bronze and iron bushes started only in 1958. Since then considerable progress has been made. Nowadays a variety of components such as self-lubricating bearings, bushes,

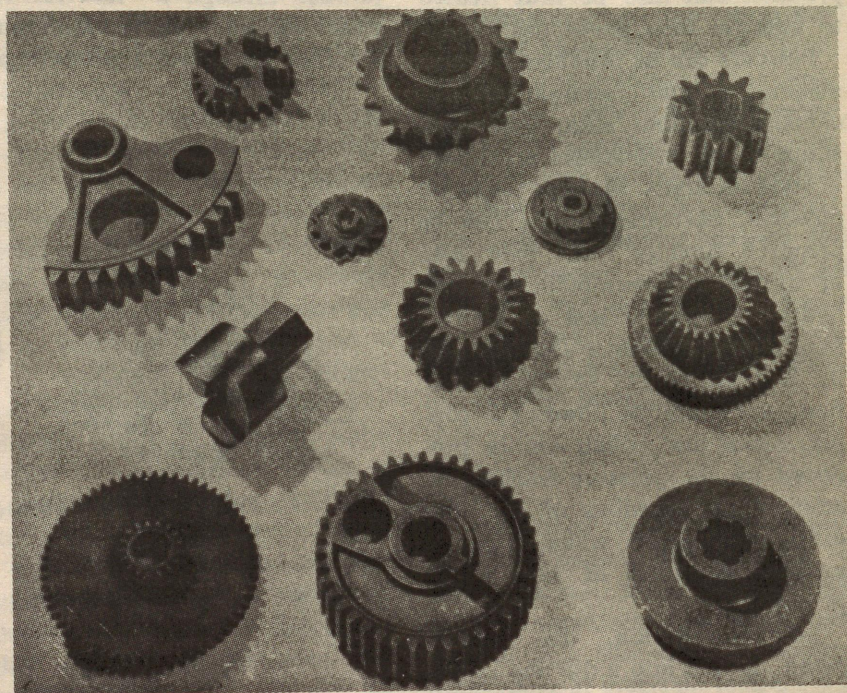


Fig. 4. Some powder metallurgy products

Powder metallurgy know-how developed

INDIA has achieved significant success in the advanced technology of producing metal powders.

Some national Laboratories under Council of Scientific and Industrial Research have developed processes for the production of metal powders of iron, zinc, copper, lead, tin and brass. They have also developed processes to produce powder alloys of two or more metals.

Powder of metals are used in sophisticated industries such as manufacture of engines, machines tools, pigments, and electrical appliances. At present most metal powders are imported.

The know-how of the National Metallurgical Laboratory, Jamshedpur, for producing extra fine metal powders of non-ferrous metals such as copper, aluminium, tin, lead and brass has been worked out on pilot plant scale. The Jamshedpur Laboratory has

also produced extra fine zinc dust for use in chemical industry. The demand for fine zinc powder in India is 6,000 tonnes which is presently imported.

The NML process produces extra fine zinc dust, both from pure zinc metal and from industrial wastes containing zinc. In another experiment, the Jamshedpur Laboratory has successfully produced the alloy powders of copper, lead and bronze. These powder alloys are used in the manufacture of engines.

Another CSIR laboratory, Central Electro-Chemical Research Institute, Karaikudi, has developed a process for producing powder of iron by electrolytic method. Iron powder is used in machine building industry. The CECRI know-how can produce fine iron powders from low-grade iron ores also. The Institute has also developed the know-how for annealing of iron powder so obtained.

rature applications like jet vane, rocket throat inserts, etc., made out of refractory materials. Beryllium powder metallurgy products are used for sophisticated instrumentation system required for guidance and control. Scientists at the National Aeronautical Laboratory, Bangalore, are studying the production of reactive metal powders such as titanium, zirconium etc., by vacuum atomisation. Defence Metallurgical Research Laboratory, Hyderabad, has done extensive research and developmental work in the field of cemented carbides, sintered ordnance components, isostatic and explosive compaction and a variety of products such as contact materials, cermets, ferrites, and dispersion-strengthened materials. Extensive research and development work is going on in the field of powder production, sintering, development of sintered products at BARC, DMRL, National Metallurgical Laboratory, Jamshedpur, Central Electro-Chemical Research Institute, Karaikudi and various other institutions.

filters and structural parts are made and used in automobiles, scooters, electrical fans, home appliances and textile machinery. Considerable savings have been achieved by the use of these products. Cemented carbide products such as cutting tools, drilling rods, bits, dies and other components are also made in substantial quantities. Other products include metal graphite brushes, contact materials and ferrites. Powders such as aluminium, zinc, tin, silver, magnesium, tungsten, copper, iron, etc., are also made in good quantities. The production of special powders such as bronze, copper-lead, copper-lead-tin, etc., will also be scaled up in the near future. Considerable research and development work is being done in the field of powder metallurgy in our national labora-

tories and technological institutions.

Powder metallurgy as a fabrication technique plays an important role in the development of atomic energy. It is used for the production of fuel elements, cladding materials, moderator and control rods. Bhabha Atomic Research Centre, Bombay has done much work in this field. The know-how developed by BARC is being utilised by the Nuclear Fuel Complex at Hyderabad for the fabrication of fuels for reactors at the Tarapur and Rajasthan Atomic Power Stations. Work is also going on a number of high temperature materials like molybdenum, cermets and certain fissile materials like thorium. At Vikram Sarabhai Space Centre, Trivandrum, work is in progress for the development of materials for extreme high tempe-

Powder metallurgy research and developmental work have been pursued at IIT, Bombay for the past 16 years. These include powder production, characterisation, sintering, structure-property evaluation of sintered products, ferrites, composite materials, hot pressing, powder rolling and preform forging, etc. Even though tungsten is made by powder metallurgy, sintered tungsten bars and rods are not so far made in our country and these are imported and subsequently processed to produce bulb filaments and other products. A public sector enterprise has been recently set up by the Government which is expected to produce in the near future, tungsten and molybdenum products alongwith other advanced materials such as titanium base alloys and a variety of super alloys.

ANTIDIARRHOEAL DRUGS

—Safe or Unsafe ?

H. H. SIDDIQUI

There is an international debate on the "toxicity" of the anti-diarrhoeal drugs in common use today

EXCESSIVE preoccupation with drug toxicity rather than objective appraisal characterizes much of the recent newspaper reports on the toxicity of Entero-Vioform (Commercial names of the drugs have been used in the article because readers are more likely to be familiar with them) and Mexaform. This was based on an article published in *Lancet* (1977).

According to Charaka (about 1000 B.C.): 'A drug that is not understood perfectly is comparable to poison, weapon, fire and thunderbolt, while the well-understood drug is comparable to ambrosia'.

I am reminded of the sayings of Oliver Wendel Homes (1860): 'I firmly believe that if the whole *Materia medica* as now used, could be sunk to the bottom of the sea, it would be all the better for mankind—and the worse for the fishes.' 'Why this hue and cry over Entero-vioform when every drug has ad-

verse effects on some people?', asks Professor U.K. Sheth of Bombay.

These quotations warn us of potential toxicity of all drugs of all times including modern drugs. And therefore the problem of Mexaform toxicity also requires thorough scientific assessment. At the same time there is no reason for creating panic and fear in the minds of people. Drugs like Dependal, Dysenchlor, Entero-Quinol, Entero-Vioform, Folestine, Intestopen-In, Mexaform and Unienzyme have been used in India for several years and till today no epidemic of the nature discussed in the English medical literature has been noticed by clinicians.

Halogenated hydroxyquinoline

The development of antidiarrhoeal and antiamoebic drugs is related with the visit of people from countries like Belgium, France, Germany, Great Britain and Holland

during their Empire in the tropical countries. They used to suffer frequently from the tropical diseases. And this led to the development of drugs for tropical diseases. For dysentery, emetine and chiniofon were developed about 60 years back. The rational use of emetine as an amoebicidal drug dates from 1912 and had been most widely used. Chiniofon was the first drug of the halogenated hydroxyquinoline group used for the treatment of diarrhoea and amoebiasis. Fig. 1 shows the chemical structure of quinoline, 8-hydroxyquinoline and some of its widely used halogenated derivatives.

Table 1 shows the commercial names, composition, official names and the therapeutic doses of commonly used drugs containing halogenated quinolines. These drugs are being used extensively in India to treat diarrhoea and intestinal amoebiasis. In acute diarrhoea,

Table 1 - Commonly used antidiarrhoeal, antiamoebic and enzyme preparations containing halogenated quinolines

Commercial name	Official name and composition (per tablet)	Dose
1. <i>DEPENDAL</i> (SKF)	Furazolidine 100 mg Vioform 200 mg	1-2 tablets three times a day
2. <i>DYSENCHLOR</i> (Surhid Geigy)	Chlorquinaldol 100 mg	2 tablets three times a day
3. <i>ENTERO-QUINOL</i> (East India Pharm.)	Vioform 250 mg	1-2 tablets three times a day
4. <i>ENTRO-VIOFORM</i> (Ciba)	Vioform 250 mg	1-2 tablets three times a day
5. <i>FOLESTINE</i> (Sandoz)	Broxyquinoline 500 mg Brobenzoxaldine 100 mg Hyoscyamine 0.028 mg Hyoscine 0.0026 mg	1 tablet three times a day
6. <i>INTESTOPAN-IN</i> (Sandoz)	Broxyquinoline 200 mg Brobenzoxaldine 40 mg Hyoscyamine 0.028 mg Hyoscine 0.0026 mg	1-2 tablets three times a day
7. <i>MEXAFORM</i> (Ciba)	Phanquone 20 mg Vioform 200 mg Oxyphenonium 2 mg	1-2 tablets three times a day
8. <i>UNIENZYME</i> (Unichem)	Diastase 200 mg Papain 30 mg Thiamine 2 mg Riboflavine 2 mg Nicotinamide 25 mg Diphenhydramine 20 mg Vioform 125 mg Homatropine 1.25 mg Methyl polysiloxane 25 mg Activated charcoal 75 mg Acetophenolisatin 0.5 mg	1-2 tablets three times a day

generally two tablets are taken three times a day. In most cases the treatment continues for 2-3 days. But in intestinal amoebiasis it is usually given for 7-10 days. Each packet of these drugs carries the warning: 'Relatively prolonged and uninterrupted treatment with halogenated hydroxyquinoline derivatives used in high dosage for more than 14 days have been reported

to cause peripheral neuritis and damage to the optic nerve in isolated cases.'

Subacute myelo-optic neuropathy (SMON) and vioform

During 1956, many Japanese suffered from an unusual combination of gastro-intestinal and neurological complaints. The symptoms were abdo-

minal pain, diarrhoea, followed within a few days or weeks by painful and persistent sensation induced by gentle touch of the skin—in addition to other sensory disturbances—and visual disorders due to inflammation of the optic nerves. This disease was called SMON. During the whole course of epidemic, which ran from 1956 to 1970, some 10,000 Japanese were afflicted by this disease. Only

180 cases have been identified outside Japan including 9 cases by Professor N.H. Wadia, an eminent neurologist of Bombay.

Greenish colouration of tongue, faeces and urine was noted in Japanese patients of SMON (Meade, 1975). The green colour is believed to be due to the iron chelate of vioform. It is not clear whether iron chelate is responsible for the damage of the nervous system. It is possible that the Japanese might be absorbing this chelate more readily or are more sensitive to it than others. The SMON toxicity of vioform has been observed to be dose-related. For example, at a dosage of 750 mg/day for 4 weeks or less, there is little risk of toxic reactions (Kono, 1971; McEwen, 1970, 1971). Neurological symptoms develop in approximately 1% of patients who take doses of 750-1500 mg/day for less than 2 weeks (Tsubaki *et al*, 1971; Nakae *et al*; 1971). Approximately 35% of patients who take doses of 750-1500 mg/day for longer than 2 weeks develop symptoms (Tsubaki *et al*, 1971; Yoshitake and Igata, 1971). A dose of 1800 mg/day causes the onset of symptoms as early as the 5th day (Nakae *et al*, 1971). Two of the case reports are particularly enlightening because they demonstrate, in individual patients, important quantitative points of vioform dose and neurotoxic response (Oakley, 1973). One of Selby's (1972) patients took 500 mg to 750 mg of vioform per day for more than a year without symptoms. Six weeks after he had begun to take 1500 mg/day, neurological symptoms developed. Kaeser and Wuthrich (1970) reported that neuropathy developed in a woman patient while she was taking 1500 mg/day. The neuropathy improved when the dosage was lowered to 750 mg/day, and became worse when it was again increased to 1500 mg/day.

SMON is a clinical condition which usually occurs after abdominal symptoms like diarrhoea and consists primarily of the damage of the spinal cord (myelopathy). There is also damage of peripheral nerves which is manifested by abnormal sensation (paraesthesia) in the lower limbs. In some patients involvement of the nerve of the eye (optic nerve) leads to disturbances of vision. SMON has only recently found its place in Western monographs and books on the diseases of nervous system although it is known to have afflicted Japanese and has been reported by them since 1956 (Meade, 1975). A voluminous literature on all aspects of the disease has accumulated in Japan, but there have been only occasional cases reported from Australia, France, Great Britain, Holland, India, Singapore, Sweden, Switzerland and U.S.A. (Wadia, 1977). The disproportionately high prevalence of this disease in Japan has been commented upon by the Japanese themselves.

Today the diagnosis of SMON outside Japan is largely based on the acceptance of the Japanese experience (Osterman, 1971; Selby, 1972). In day-to-day practice of neurology, one comes across patients who resemble those diagnosed as SMON but they differ in that they do not suffer from preceding diarrhoea or other gastro-intestinal disturbances and may not have taken vioform (Wadia, 1977).

SMON in India

Professor B. N. Tandon, the Gastroenterologist of AIIMS pointed out (*personal communication*) that he has not personally come across any patient of SMON definitely linked with Entero-Vioform or other halogenated quinolines. He, however, stopped prescribing iodo or iodo-chlor derivatives of quinoline since Japan's report in 1970. In his view

we do not have such adverse reports on the bromo derivatives of quinoline (Table 1). Professor Tandon's view is supported by the report of Professor N.P.S. Verma of Maulana Azad Medical College, New Delhi, who tried Intestopan in a dose of 480 mg three times a day for 5 days in a double-blind clinical trial for the treatment of diarrhoea. The study was carried out over a period of one year. He did not notice any case of SMON.

Gangadhar Sharma (1975) has reported remarkable clinical improvement in lepromatous lesions with Intestopan Forte capsule given three times a day for six months. This has been so far tried in 56 leprosy patients for upto one year. Throughout the period of therapy no serious adverse reactions have been encountered.

Professor V. Virmani, Neurologist and Prof. R. Batta, Ophthalmologist (both of AIIMS) did not come across any case of SMON linked with halogenated quinolines (*personal communication*).

Professor N.H. Wadia of Bombay acquired first-hand knowledge of SMON during a visit to Japan in 1972. After his return to Bombay, he carried out retrospective search of over 5,000 case histories and prospective search of 4½ years and found only 9 cases of SMON. In these cases there was history of vioform intake, and therefore vioform could not be excluded as an etiological agent. Three cases resembling SMON were scrutinized from 1970-72 records by Dr. Gouri Devi, Neurologist, Safdarjang Hospital, New Delhi (*personal communication to Professor B.N. Tandon*).

Altogether there appears to be 12 patients reported from India. These Indian patients differ greatly from their Japanese co-sufferers in that there was absence of abdominal complaints. Dr. Gouri Devi's three patients did not deteriorate even

when they continued to take vioform. Wadia (1977) has stressed that against 10,000 cases of SMON reported from Japan over a 15 year period (Meade, 1975; *Lancet*, 1977; Iwarson, 1977) he was able to find only 9 cases in Bombay in 9 years. Even if there were 180 such cases throughout the world outside Japan, the number would be trivial, bearing in mind the number of people who have taken vioform. Professor Wadia (1977) thinks, and probably on sound reasons, that clinicians in and around big neurological centres in India would not have missed SMON cases after the Japanese experience.

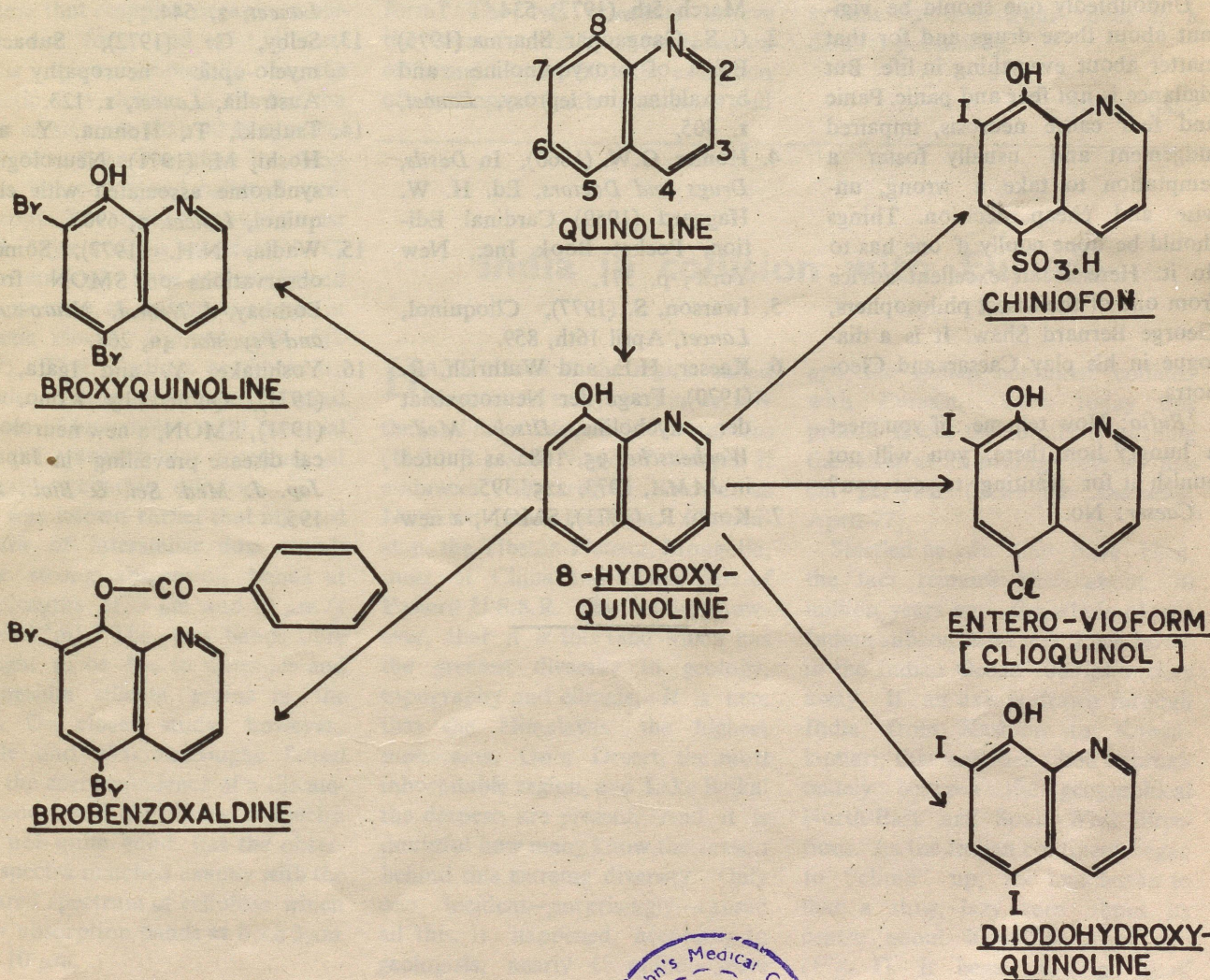
Publicity—What next?

On the recommendations of the Indian Council of Medical Research, the Drug Control Authorities have now (Circular letter No. 12-105/70-DC, dt. 1.7.77) indicated that all halogenated hydroxyquinoline containing preparations be available to the public only on the prescription of a registered medical practitioner.

Several theories have been proposed about the etiology of SMON. It has been suggested that there is some factor in addition to vioform (if vioform is at all involved), for example, infectious etiology such

as virus infection, several agricultural and environmental pollutants, possibility of racial or genetic pre-disposition leading to greater vioform toxicity, interaction of vioform with other drugs, etc.

Many persons in India (Wadia, 1977) take more than 10-40g of vioform, the dose deemed sufficient to cause SMON in Japan (Kono, 1971). Also, there are many Indians who are habitual users of drugs like Unienzyme for indigestion and flatulence. Unienzyme contains 125 mg of vioform besides other ingredients. It would be wrong to ban drugs like Entero-Vioform in a tropical country



like India in haste. The question of toxicity and activity should always be relative. In India, where a large number of people suffer from chronic gastro-intestinal disturbances, the benefit derived from taking these drugs should not be overlooked. However in 1977, it would be imprudent totally to ignore the Japanese experience. In India, more attention should be given to *Pahadis*, Nepalese and people from Nagaland who are ethnically more close to Japanese. If the factor responsible for SMON is genetic, SMON may never appear in India on an epidemic scale. But if the factor is environmental, infective or due to drug interaction, then SMON may appear in India also (Wadia, 1977).

Undoubtedly one should be vigilant about these drugs and for that matter about everything in life. But vigilance is not fear and panic. Panic and fear cause neurosis, impaired judgement and usually foster a temptation to take a wrong, unwise and cheap decision. Things should be done coolly if one has to do it. Here is an excellent advice from one of the wisest philosophers, George Bernard Shaw. It is a dialogue in his play *Caesar and Cleopatra*.

Rufio: Now tell me : if you meet a hungry lion there, you will not punish it for wanting to eat you?

Caesar: No.

Rufio: Nor revenge upon it the blood of those it has already eaten.

Caesar: No.

Rufio: Nor judge it for its guiltiness.

Caesar: No.

Rufio: What then would you do to save your life from it?

Caesar: Kill it, man, without malice, just as it would kill me.'

The same wise attitude must prevail in considering any problem in public life, drug or no drug.

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SCIENCE SPECTRUM

Cellulose in interstellar space

IT has been known for quite some time that complex organic molecules can form and exist in interstellar space, especially in the galactic dust clouds. In the last ten years or so more than 40 such molecules have been identified by using radio telescopes and infrared spectroscopy. The British astrophysicist Fred Hoyle and his associate N. C. Wikramasinghe have now confirmed the presence of polysaccharides in galactic clouds (*Nature*, 268, 610 1977). Their findings are based on the close similarity between infrared spectra of interstellar solid material and the transmittance spectrum of the polysaccharide, cellulose.

It was known earlier that infrared spectra of interstellar dust clouds show strong absorption bands at wavelengths of $3\ \mu\text{m}$ and $10\ \mu\text{m}$ ($1\ \mu\text{m} = 10^{-6}\text{m}$). The two bands were thought to be due to water-ice and magnesium silicate grains in the dust. On closer study, however, Hoyle and Wikramasinghe found that the correspondence of a silicate-ice model and the observed spectra was not quite good. But the observed spectra matched exactly with the infrared spectrum of cellulose which show absorption bands at both $3\ \mu\text{m}$ and $10\ \mu\text{m}$.

How did the polysaccharides form? The two scientists believe they were formed by polymerisation of formaldehyde. With the exception of hydrogen (both molecular and

ionised), water (vapour and ice) and carbon monoxide (CO), the most abundant molecule in the interstellar medium is formaldehyde (HCHO). This molecule can undergo polymerisation in many ways. (Such a polymerisation process could be initiated by the action of ionizing radiation.) The resultant polymers are quite stable. Among them, the common polysaccharides, cellulose and starch, are particularly so because each glucose unit ($\text{C}_6\text{H}_{12}\text{O}_6$) in these molecules can form itself into a very stable ring.

This new discovery points to the fact that very large molecules (macromolecules) can form and exist under interstellar conditions. It also shows that evolution of prebiotic molecules or a primitive biological system in interstellar space is a distinct possibility.

BIMAN BASU

India in collision with Eurasia

HAVE a look at the region called Eurasia. As every one knows, it is the land mass East of Ural mountains (U.S.S.R.) and North of Ganges. It embraces the region known as Northern India, Pakistan, Afghanistan, the Tibetan Plateau, Mongolia, most of China and a large part of Eastern U.S.S.R. Few know, however, that it is this land which has the greatest diversity in geology, topography and climate. It is here that the Himalayas, the highest mountains, Gobi Desert, the most inhospitable region, and Lake Baikal the deepest, are present. And it is doubtful how many know the reason behind this extreme diversity. Only one incident—surprisingly—caused all this. It happened, according to geologists, nearly 45 million years

ago: the Indian continent collided with Eurasia. Even today this process is on, the former is pushing the latter at an average rate of five cm per year. (*Scientific American*, April 77).

Startled as you may have been, the fact remains that about 70 million years ago, the whole of the Indian subcontinent was down below in the Indian Ocean 7000 kilometers away. If an axis is drawn through India, from Kashmir to Kanyakumari, this was then tilted approximately between the geographical North-East and South-West directions. As the Indian continent began to "climb" up, the axis began to take a slow, lazy turn about its centre about 40 million years ago (Fig. 1). It began to align itself

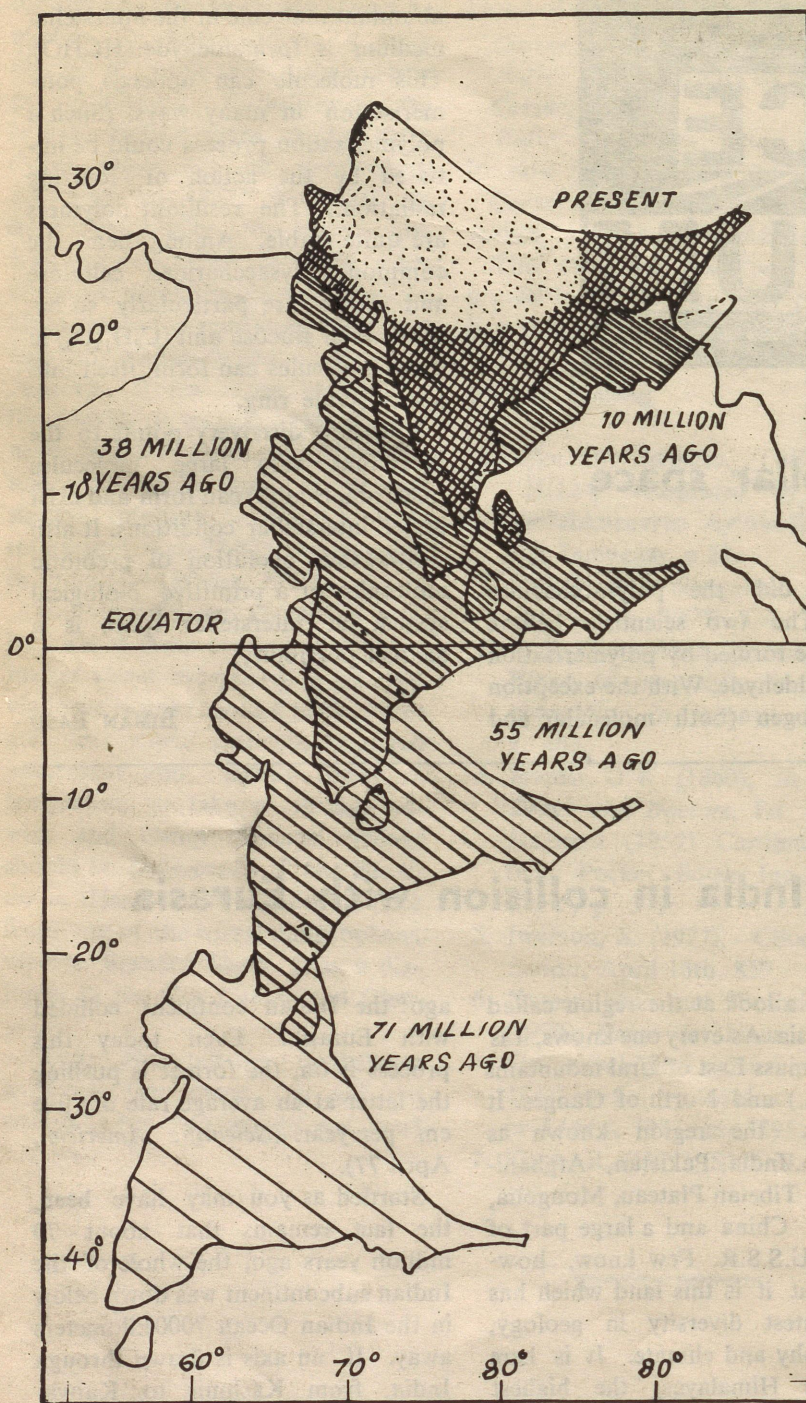


Fig. 1

along the North-South direction. The Indian continent was hastened up to do so when it collided with the Eurasian land mass.

Apparently, the two continents did not instantly merge their boundaries as they appear today. The merging was a gradual process. First they joined "hands" at one point and then slowly swallowed up the sea in between, and finally the real struggle between them ensued, which is still on.

This "jutting" up of Indian continent into the Eurasian land mass produced innumerable consequences. The Himalayas were produced, the Tibetan plateau and the Tien Shan range were raised. Apart from drastic changes in climate which resulted, some 3000 kilometers of land along north and east of Himalayas became prone to earthquakes. So much so that of the last 22 greatest recorded earthquakes, seven occurred in this region. Added to this are indications that China is being pushed along the NE-SW and N-S axes into the Pacific Ocean!

Geologically, how all this came about is the issue which cannot be avoided. For that, consider the plate tectonics theory. Imagine the surface of the earth comprising of thick rigid plates. These plates consist of earth's crust and some layers, and they float on the inner fluid layer of the earth known as mantle. Continents are those regions which ride on these plates which, being at higher elevations, stand above the water around. So, the Indian continent approached the Eurasian because of the internal plate movement. Their movement created the same consequences as are produced when a metal plate pushes a sheet of velvet. The land mass between their boundaries was raised vertically and compressed along the edges of the plates, pushing up mountains and creating a weak internal structure so as to become highly susceptible to earthquakes. China is being pushed north-eastwardly into the Pacific because the land mass on the west side is much larger and heavier to push.

DILIP M. SALWI

Nature also is a polluter

THERE has been a lot of controversy in recent years over the pollution of rivers, lakes and the seas by pesticides and halogenated organic compounds like DDT, and the polychloro biphenyls (PCBs). Many industrial effluents contain halogen compounds which when discharged into water courses without pre-treatment cause pollution.

Till recently it was believed that such pollution was exclusively man-made. But it has now been discovered that nature also has a share in it. Halogenated organic compounds are now known to occur naturally in coastal waters; their source: the various species of seaweeds, molluscs, sponges and bacteria that abound in the marine environment.

Take the red algae, or Rhodophyta, for example. They synthesise an impressive variety of organic substances, many containing chlorine and iodine. The products range from low molecular weight halomethanes and ketones to higher molecular weight terpenes and fatty acid-like compounds. William Fenical, a scientist of the Scripps Institute of Oceanography, U.S.A., has listed more than 80 such halogenated organic compounds (*Environ. Sc. & Tech.*, May 1977). Among Fenical's findings is a red seaweed of the genus *Asparagopsis*, which produces small amounts of the toxic chemical carbon tetrachloride. Other compounds found in that same weed include bromoform and halogenated acetones. One such compound, monobromo acetone, is a principal component of tear gas.

Much of the evidence about these natural pollutants has come in course of screening of marine

plants for pharmaceutical materials. None of the organisms tested so far has been found to produce substances similar to D.D.T. or

related compounds. But that, Fenical cautions, does in no way reduce the significance of natural organohalogen compounds as pollutants. And for any evaluation of water pollutants, especially in coastal areas, this factor should be taken into account.

BIMAN BASU

Synthesis of element 106

THE element with the atomic number 106 is the fourteenth of the synthetic transuranium elements. The discovery of this element took place in 1974 nearly simultaneously in two laboratories, the Lawrence Berkeley Laboratory at the University of California, U. S. A. and the Joint Institute for Nuclear Research at Dubna near Moscow in the U.S.S.R. Neither group has suggested any name for the element. Consequently, for the time being, it will have the simple designation "element 106". On the basis of its projected position in the periodic table, element 106 is expected to have chemical properties similar to tungsten.

The Berkeley Group headed by A. Ghiorso used the Super-Heavy Ion Linear Accelerator as its source of heavy ions. They bombarded a target of californium (the isotope ^{249}Cf , atomic number 98 and mass number 249) with ^{18}O ions of energy 95 MeV and intensity 3×10^{12} ions per second. This resulted in the production of element 106 with the mass number 263, which decays with a half-life of 0.9 ± 0.2 sec by emission of alpha particles. In this reaction four neutrons are emitted.

The new element was identified by its decay products. The decay sequence is $^{263}_{106}\text{X} \xrightarrow{\alpha} ^{259}_{104}\text{Rf} \xrightarrow{\alpha} ^{255}_{102}\text{No} \xrightarrow{\alpha}$ (Rf is element 104—mitochondrion, and No is element 102—nobelium). The genetic linkage was established by specially designed apparatus in which $^{263}_{106}\text{X}$ atoms were swept in a stream of helium gas to the surface of a wheel that could be rotated close to solid-state detectors in such a manner that the emitted alpha particles from $^{263}_{106}\text{X}$, $^{259}_{104}\text{Rf}$ and $^{255}_{102}\text{No}$ could be recorded in their natural time sequence. The operation of the apparatus was controlled by a computer which also recorded on magnetic tape all the experimental data. A total of seventy three $^{263}_{106}\text{X}$ emitted alpha particles and approximately the expected corresponding number of $^{259}_{104}\text{Rf}$ and $^{255}_{102}\text{No}$ alpha particles were recorded.

The Dubna Group, headed by G. N. Flerov and Yu. Ts. Oranesian produced the required heavy ions with a 310 cm heavy-ion cyclotron. They chose lead as the target and bombarded ^{207}Pb and ^{208}Pb with ^{54}Cr ions of 280 MeV energy and intensity 2×10^{11} ions per second. The result was a product that decays with a very short half-life of 7 milli-

sec. They assigned it the structure $^{259}\text{106}$, suggesting reactions in which two or three neutrons are emitted: ^{207}Pb , (^{54}Cr , 2n) and ^{208}Pb (^{54}Cr , 3n). In the Dubna experiments the ^{54}Cr ions impinged on the lead target on the surface of a rotating disc. The product nuclei, decaying

by spontaneous fission, were detected using dielectric mica detectors. A total of 51 spontaneous fission events were ascribed to $^{259}\text{106}$.

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Importance of sodium chloride

THERE is no inorganic compound which is taken as such in the human body except sodium chloride. Most foods are organic in form, but sodium chloride (NaCl)—the common table salt—is consumed as such by all human beings, rich or poor alike. The necessity and dietary importance of common salt can hardly be overemphasized because of its being a basic ingredient of our daily diet. The common salt is generally recognized as a stimulant. Anthropologists have pointed out that ancient civilizations developed in areas near either sea or dried up seas and lakes where good supplies of salts, particularly sodium chloride, were available.

Of more than 50 elements found in the human body, some are present in large quantities while others in small quantities. Sodium ions account for nearly 93% of the cations present in human blood and are taken primarily in the form of sodium chloride. Sodium is found mainly in the extracellular body fluids. Chloride is found largely in blood plasma and fluids outside cells of the body. When taken in small amounts, salt is immediately eliminated from the body through sweat and urine. But in larger doses, it is retained in body tissues and blood stream resulting in a state of hyperchloremia. In this condition salt in an above average amount circulates in blood stream. If there is rapid sweating,

the amount of salt in blood is lowered, a state of hypochloremia follows and one starts feeling depressed.

Sodium helps in the regulation of acid-base equilibrium, cell permeability, in the maintenance of normal nerve irritability, water balance and osmotic pressure. When the human body contains abnormally large amounts of sodium ions it tends to retain water and a condition known as edema is obtained. Persons who develop edema are advised to reduce consumption of salt. Additional sodium may be needed following extensive loss of profuse sweating, recurrent vomiting, protracted diarrhoea, burns and a prolonged use of diuretics. Salt deficiency in the system produces symptoms like nausea, headache, dullness, anorexia (lack or loss of appetite for food), muscle weakness, and in some cases mental confusion.

There are evidences of the effects of low as well as high intakes of common salt in both animals and men. It has been suggested that a high intake of common salt over a long period of time may cause a greater risk of hypertension. Sodium chloride has an important effect on the capillary activity and on the consumption of oxygen of the body. A healthy man kept on 15 g salt per day for 14 days showed an increased blood pressure, an increased basic metabolic rate and

coarsened and thickened capillary walls. But when he was put on a diet poor in salt, i. e., 2 g per day, none of the above symptoms were observed.

An average adult consumes about 5g to 7g of salt in a day. However, this requirement may increase under those environmental and climatic conditions that cause increased sweating. Sodium ions are found in all body fluids and very little in the cells. On the other hand, there is relatively high concentration of potassium ions within the cells. Such a difference in concentration of sodium and potassium ions inside and outside the cells is vital to their functioning as is most readily seen in studies on highly irritable tissues such as muscle or nerve. When a nerve impulse passes, potassium ions flow out into the surrounding medium and sodium ions flow into the nerve cells. For another impulse to be conducted by that nerve cell, sodium ions must be pumped out, and potassium ions must enter. The whole process occurs in milliseconds.

Salt poisoning is very harmful and can be diagnosed only by careful chemical examination of secretions such as mucus, tears, gastric juice, urine, joint fluids, spinal fluid and blood. The best way to eliminate the deleterious effects of eating salt is to eliminate it from diet. Instead it can be eaten in organic form present in leaves and fruits. In organic form it is never so harmful. Some substitutes of NaCl such as monosodium or monopotassium glutamate are sold in the market, but they too have harmful effects.

It is thought that salt irritation of brain causes insanity. Salt can diffuse into cerebrospinal fluid and inflame the brain cells causing irritation and insanity.

Chloride is the principal anion of the body. No specific function of chlorine is known. Perhaps it is the

most commonly available and convenient anion to balance the cations (sodium and potassium) in the body fluids. Though very little is known about the exact required quantity of sodium chloride in the diet, it is suggested that normal requirement is more than met from the food containing natural salt and the salt which is added to the food during cooking.

Sodium chloride provides a good example of difference between nutrition and stimulation. What cons-

titutes nutrition may also destroy the vital organs causing permanent damage to the human body.

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Emulsions

IN recent years emulsion technology has become an integral part of our life and industry. Various industries like paints, cosmetics, food, medicines, agricultural sprays, polishes, etc., depend on emulsion technology. No aspect of life remains untouched with this conspicuous colloidal system consisting of tiny droplets of one liquid dispersed into another. The commonest example is milk, the perfect food for infants.

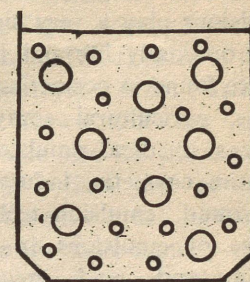
Two immiscible liquids give rise to the formation of an emulsion. The two common types of emulsions are oil-in-water (o/w) and water-in-oil (w/o). Factors influencing these types of emulsions are the oil-water ratio and the stabilizer used.

From the thermodynamic point of view, emulsions are essentially unstable, they break up with time forming two distinct layers of the immiscible liquids. Spontaneous joining of tiny droplets in the emulsion to form bigger ones (coalescence) and resulting in two separate layers is termed as "Breaking" (Fig. 1). Creaming is a sedimentation process occurring due to the different densities of the dispersed and conti-

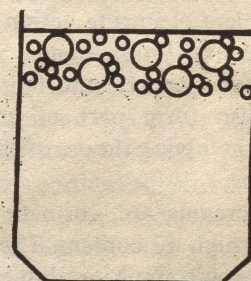
nuous phases. Flocculation is the process of aggregation or mutual sticking of droplets forming three-dimensional clusters without coalescence. An example of flocculation is the curdling of milk.

Emulsions are stabilized by certain surface-active agents called emulsifiers. They are adsorbed on the surface of the dispersed droplets forming a tough interfacial film resistant to flocculation and coalescence. Moreover, the dissociation of emulsifier into its ions induces similar charge on the droplets creating an electrostatic repulsive force between the tiny droplets which inhibits flocculation.

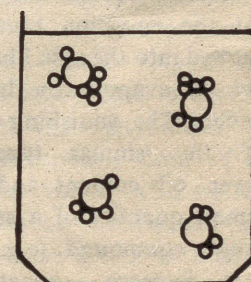
Emulsifiers exhibit high surface activity. Soap and detergents are the most efficient surfactants. They contain one or more hydrophobic groups (alkyl or aryl groups) along with one or more hydrophilic groups (anionic, cationic or non-ionic) within the same molecule. Such molecules are strongly adsorbed or oriented at an oil/water interface and form fairly persistent emulsions. Certain macromolecular substances like proteins, gums, starches, and polymers, also act as efficient emulsifying agents.



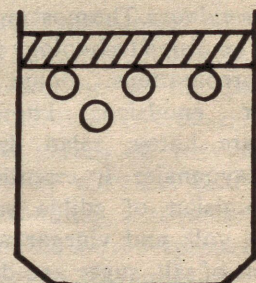
ORIGINAL EMULSION



CREAMING



FLOCCULATION



COALESCENCE

Fig. 1. Schematic representation of types of instability in emulsions

Emulsion applications

Emulsions play a very significant role in our daily life and industry. They are found in cosmetics, paints, polishes, agricultural sprays, food emulsions, medical emulsions, etc. The entire cosmetic industry centres around emulsion technology. The use of emulsions in lotions, vanishing and cold creams, for example, increases their penetration into the skin. Additional advantages of emulsions in cosmetics are economy, ease of application and efficient cleansing action. Apart from beauty lotions and various creams, deodorants and hair shampoos also form part of cosmetic industry involving the use of oil/water emulsions.

Cold creams are cosmetic emulsions of high oil content. They were originally w/o emulsions but are now being replaced by o/w emulsions. The cooling sensation, characteristic of cold creams, occurs due to the fact that the emulsion breaks on being rubbed into the skin liberating water whose evaporation has the desired effect. The vanishing creams are of the similar type but with lower oil content and contain a small quantity of a strongly hydrophilic compound (e.g., glycerine) to increase penetration. Even more dilute o/w emulsions are employed as hand lotions, facial milk, etc.

Food emulsions. The most important field of emulsion technology involves food preparations. Some of the familiar emulsions known to man are butter, salad dressings, etc. Mayonnaise is essentially an o/w emulsion of edible vegetable oil, egg yolk and vinegar with the addition of salt, sugar and dextrose. The high stability of this food emulsion is attributed to the presence of egg yolk which contains lecithin and cholesterol as emulsifiers. Similarly, the salad dressing is also an o/w emulsion largely stabilized by egg

yolk. Ice cream is an emulsion of butter fat, non-fatty milk solid, air and water. At low temperatures, the stability of the emulsion is greater due to the increased viscosity.

The use of emulsifying agents in baking is widespread. For example, the cake has a tendency to produce excessive shrinkage or falls too much on being removed from the oven. The addition of mono or diglycerides of polyglycerols improves the quality of the cake and imparts to it greater resistance to shrinkage.

Emulsion paints. An emulsion paint may be considered as a relatively simple system consisting of a vehicle (the liquid phase) and pigments, which impart colour and opacity to the painted surface. To this may be added a volatile thinner which makes application easier. Emulsion paints have certain advantages over water and oil paints. In some recent formulations of such paints, synthetic resin emulsion is used in the vehicle, the synthetic high polymer constituting, in whole or part, the "oil" phase.

Polishes are oil or wax emulsions in water which breakdown when

applied to a surface. On breaking down, the glaze imparting ingredient spreads over the surface making it smooth and glossy.

The use of chemicals as insecticides, pesticides and weed killers has long been in vogue. Agricultural sprays are usually sold as 'emulsifiable concentrates' which are solutions of toxicants in organic solvents to which is added an oil-soluble emulsifier. For use, water is added to the concentrate and the desired emulsion is prepared by shaking. Insecticide emulsion, when sprayed over plants, breaks down to deposit on the plant body a film of toxic agents that lasts quite long.

Medicines administered in the form of emulsions are easily absorbed by the human system and have a lasting effect.

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Lithium and mental diseases

ALTHOUGH lithium was introduced in medicine over a hundred years ago for the treatment of diseases like gout, rheumatic disorders, and urinary calculi (small stones formed in the urinary tract) its unique psychoactive potentiality (as lithium carbonate) in manic excitement was discovered in 1949 by an Australian scientist J. G. J. Cade (*Med. J. Aust.*, **36**, 349-352). In recent years this simple inorganic salt has brought about a revolution in psychopharmacology (a disci-

pline that deals with the mechanism of action of several psychoactive drugs), both because of its use in the treatment of mania and the promise it holds as a prophylactic agent in preventing recurrences of affective illness, a condition with a disturbance of mood either in the direction of mental depression or elation.

The three monoamines that have received most attention in the brain function are noradrenaline, dopamine and serotonin. The neural and

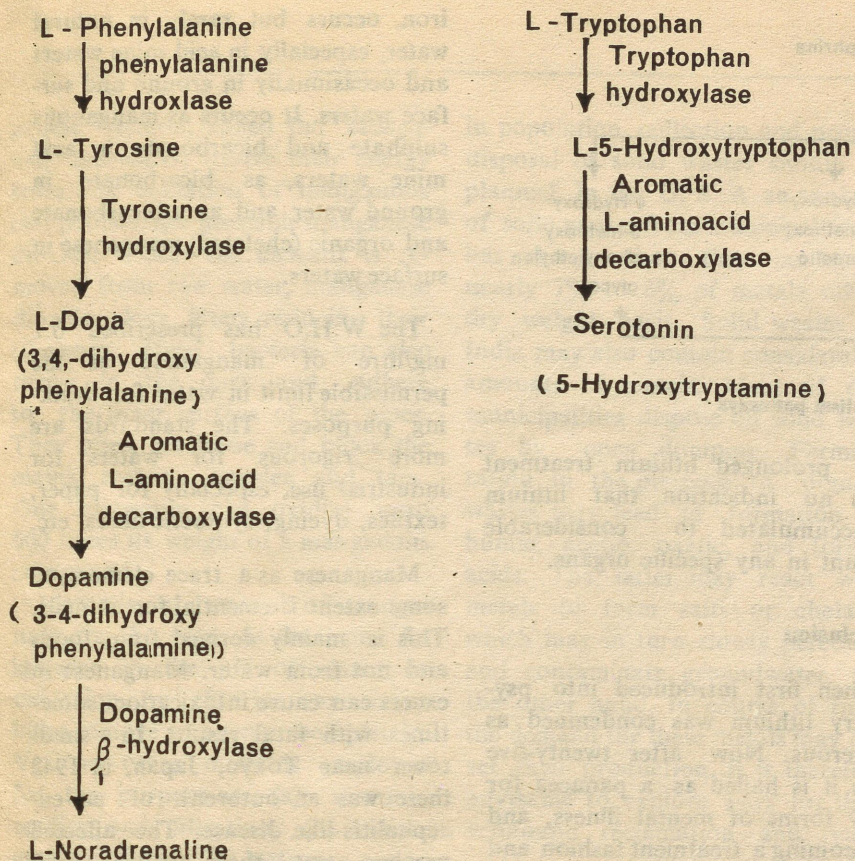


Fig. 1. Biosynthetic pathways for noradrenaline, dopamine and serotonin

biological studies indicate that these substances are located in certain nerve cells and nerve-endings. The most likely function of monoamines in specific regions of the central nervous system (CNS) is as chemical transmitters between nerve cells, or as modulators of transmission by other substances (such as acetylcholine). Catecholamines (collective term for noradrenaline, dopamine, etc.) are synthesised from the plasma amino-acids, L-tyrosine or L-phenylalanine.

The mechanism by which lithium exerts its effect on mania and depression is not yet clear. Most studies exploring the mode of action of lithium have centered round the role of monoamines in mental disorders; the second area has been the effects of lithium on body electro-

lytes. It has been proposed that during depressions a relative deficiency of noradrenaline occurs at crucial receptor sites in the brain, resulting in excessive mania. It has also been suggested that there exists a similar abnormality in serotonin metabolism. The mode of action of lithium may fit into catecholamine hypothesis of affective disorders which states that elation may be associated with increased levels of catecholamines, particularly noradrenaline. And, conversely, depression may be associated with the depletion of these monoamines at the critically effective adrenergic receptor sites in the brain.

Clinical reports on lithium suggest that there is a triphasic pattern of water and electrolyte response. First, lithium causes a marked

increase in the urinary excretion of water and sodium, and perhaps potassium and calcium too. Second, there is compensatory retention of sodium in depression and excretion during mania. Third, there is return to a stable normal state. Further, it has been shown that the monoamine uptake into the cell is dependent upon sodium and potassium gradients across the cell membrane. A defect in the sodium pump mechanism would lead to an alteration in the sodium balance and a disorganisation of monoamine uptake and synthesis within the cell. A differential effect between the two monoamine groups could be expected. For example, noradrenaline is dependent on calcium concentration for release, whereas calcium does not appear to affect serotonin release. Studies also show sodium retention in depression and its excretion during mania. It has also been found that the intracellular to extracellular lithium ratio is stable for normal individuals but may vary with behavioural changes. Lithium has also been shown to have potassium-like effect on brain respiration, i.e., it causes an increase in oxygen consumption and metabolism.

The therapeutic dose of lithium carbonate varies with individuals, and must be determined in each case by a series of estimations of the plasma or serum lithium concentration. Ordinarily lithium treatment is started at about 600-900 mg per day, reaching a level of 1200-1800 mg per day on the second day. Subsequent doses are adjusted according to the patient's clinical condition. Overdosage gives rise to a variety of toxic effects, like anorexia, transient gastric discomfort, vomiting, diarrhoea, thirst, hand tremor, slurred speech, blurring of vision, dizziness, confusion, etc. Thus it is important to establish a specific diagnosis before lithium treatment. During the treatment plasma lithium levels should be

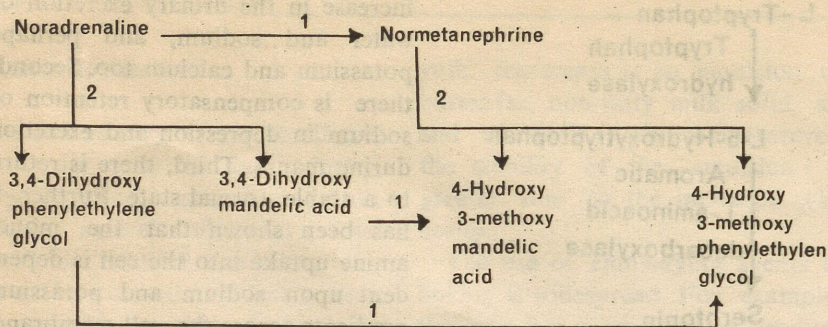


Fig. 2. Noradrenaline catabolism pathways

checked every 3 or 4 days to avoid risk of intoxication.

Lithium is excreted in faeces, sputum, sperm and sweat, but mainly in urine. In man, the highest excretion occurs about one and a half hours after ingestion. The pattern of lithium excretion and retention in normal subjects remains constant. The retention level depends on the dose; low lithium doses for prolonged periods does not cause the same retention as with higher doses for shorter periods.

Lithium is readily absorbed from all the standard routes of administration, viz., oral, subcutaneous, intramuscular and intraperitoneal, and it is not bound to plasma proteins. The oral route is the one adopted in clinical studies in man. Lithium passes from the bloodstream and an equilibrium is established between serum and cells in some tissues such as liver, kidney, spleen, muscle, bone and brain. Analysis of tissues from animals and man

after prolonged lithium treatment gives no indication that lithium is accumulated to considerable amount in any specific organs.

Conclusion

When first introduced into psychiatry lithium was condemned as dangerous. Now after twenty-five years it is hailed as a panacea for many forms of mental illness, and is becoming a treatment fashion and fad. Right at this moment it is safe to conclude that lithium is an effective agent for the manic phase of manic-depressive illness. It seems, therefore, that the possibility of using the etiology of manic-depressive illness is perhaps the most exciting aspect of its introduction into psychopharmacology.

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Manganese in drinking water

IT is said that metal pollution is worse than nuclear radiation risk, even though the latter has received greater publicity. Some of the metals found in water are mercury, cadmium, lead, arsenic and

manganese. The first four elements are not usually found in natural waters. They find access to water-sources as a result of man-made pollution.

Manganese, usually associated with

iron, occurs but rarely in natural water, especially in acid mine waters and occasionally in ground and surface waters. It occurs as manganous sulphate and bicarbonate in acid mine waters, as bicarbonate in ground water and as a bicarbonate and organic (chelated) manganese in surface waters.

The W.H.O has prescribed 0.1 mg/litre of manganese as the permissible limit in water for drinking purposes. The standards are more rigorous for waters for industrial use, especially for paper, textiles, dyeing, synthetic fibres, etc.

Manganese as a trace element to some extent is essential for animals. This is mainly derived from foods and not from water. Manganese in excess can cause intoxication, sometimes with fatal results. In a small town near Tokyo, Japan, in 1942 there was an outbreak of an encephalitis-like disease. The affected persons got their water from three of the five wells in the area. Analysis revealed that the water in these three wells contained large amounts of zinc and manganese. Water from the other two wells did not contain these metals. Examination of the surroundings revealed that over 400 dry battery cells (which contain manganese dioxide as a depolariser) were buried within 0.9 to 2.7 metres of these wells. Urine and blood samples of the intoxicated persons contained large amounts of manganese and zinc, so also the viscera of three fatal cases. Zinc however did not seem to have any deleterious effect.

Manganese in amounts 0.2-0.4 mg/litre can bring in complaints regarding taste. In this range it can cause stains on washed and cooked vegetables. Clothes washed in this water may also be stained. Manganese at these levels can also cause serious trouble in the water treatment plants and the distribution system. Man-

gane bacteria, called the *Manganese crenothrix*, derive their energy from the oxidation of manganous compounds into insoluble manganese dioxide. Unless the element is removed from raw water, manganese dioxide clogs filters reducing their efficiency. These bacteria can also thrive in the dark and adhere to the inner surface of the pipes. They often get loose and block the mains, meters, nozzles and taps. One bacterium can oxidise upto 500 times its weight of a manganous compound.

Methods of removal of manganese are the same as for iron. An increase in the pH of water or oxidation by chlorine or ozone helps remove manganese completely. Various other methods employed for the purpose are; (a) aeration, settling and filtration, (b) sodium cation exchange, (c) hydrogen cation exchange process, (d) lime soda softening, and (e) manganese zeolite process.

As there is a constant increase

in population, collection and proper disposal of solid wastes should be planned. In the U. S. A. an analysis of solid wastes from municipal areas has shown that they contained nearly 7% to 8% of metals on a dry weight basis. Solid wastes in India may also contain considerable amounts of metals. Most of our municipalities dispose off solid wastes by open dumping. Fermentation in the presence of organic wastes may lead to formation of humic, acetic, oxalic, and formic acids. The latter may react with metals to form salts or chelates which may in turn slowly percolate and contaminate groundwater. On the other hand, in course of time, the demand for these metals may offset their production. It is therefore advisable to explore ways for their economic reclamation and reuse.

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A food poison effective only in sunlight

ABALONE, also called ear-shell because of its shape, is a mollusc with a greatly flattened shell which, like the limpet, fails to cover the whole body. The outer surface of the shell is covered by a rough, horny coating over which there is usually a profuse growth of algae and bryozoa. But the inner lining of the shell has a beautiful pearly iridescence. Before the advent of plastics, the ear-shell was extensively used for mother-of-pearl buttons, brooches and trinkets.

The abalone is provided with a

powerful set of muscles by means of which the animal clings to the rocky surface of sea-shore. The large muscle is quite tasty, and the animal is an esteemed sea-food in the preparation of soup, steak or chowder. The animal moves slowly with a clumsy, swinging motion. It can be easily picked up when caught unawares, but once it is frightened and sticks to the rock, a great deal of force is required to detach it. Some species of abalone grow to over 30 centimetres (a foot).

The ear-shell (*Haliotis*) is found

in the Indian Ocean, extending up to Australia and Japan. It also occurs on the west coast of U. S. A. as well as in Africa and Europe. Usually only the muscle is eaten, but in oriental countries the entire animal, including the viscera, is consumed. In certain seasons this leads to a peculiar type of poisoning. The poison is believed to have its origin in the food, mainly sea-weeds which the animal eats.

In case of abalone poisoning there is a sudden burning and stinging sensation on the body, followed by a reaction similar to urticaria, viz., prickling sensation and itching, oedema (swelling) and erythema (reddening of skin), followed by skin ulceration. The peculiarity of this illness is that these lesions on the skin are limited only to those parts of the body which are exposed to sunlight; there is a distinct boundary between the bare and the covered portions of the body. In fact, abalone viscera poisoning is a rare instance of dietary photo-sensitization, induced by a food of animal origin. The poisoning has been found to be due to the ingestion of the digestive gland (liver) of the animal.

The illness is not restricted to humans. When laboratory animals, such as cats, rats and mice were fed *Haliotis* liver, no appreciable symptoms were seen when these animals were kept in the dark. When brought out into sunlight, however, there was a dramatic response. Starting with erythema and pruritus within a few seconds of exposure to sunlight, the animals became irritable, scratching and rubbing the skin. There were swellings on parts of the skin not covered by fur. This was soon followed by increased lachrymation (tears and salivation, intermittent convulsions, paralysis followed by death within half an hour. The animals recovered somewhat when brought back to the dark but had loss of

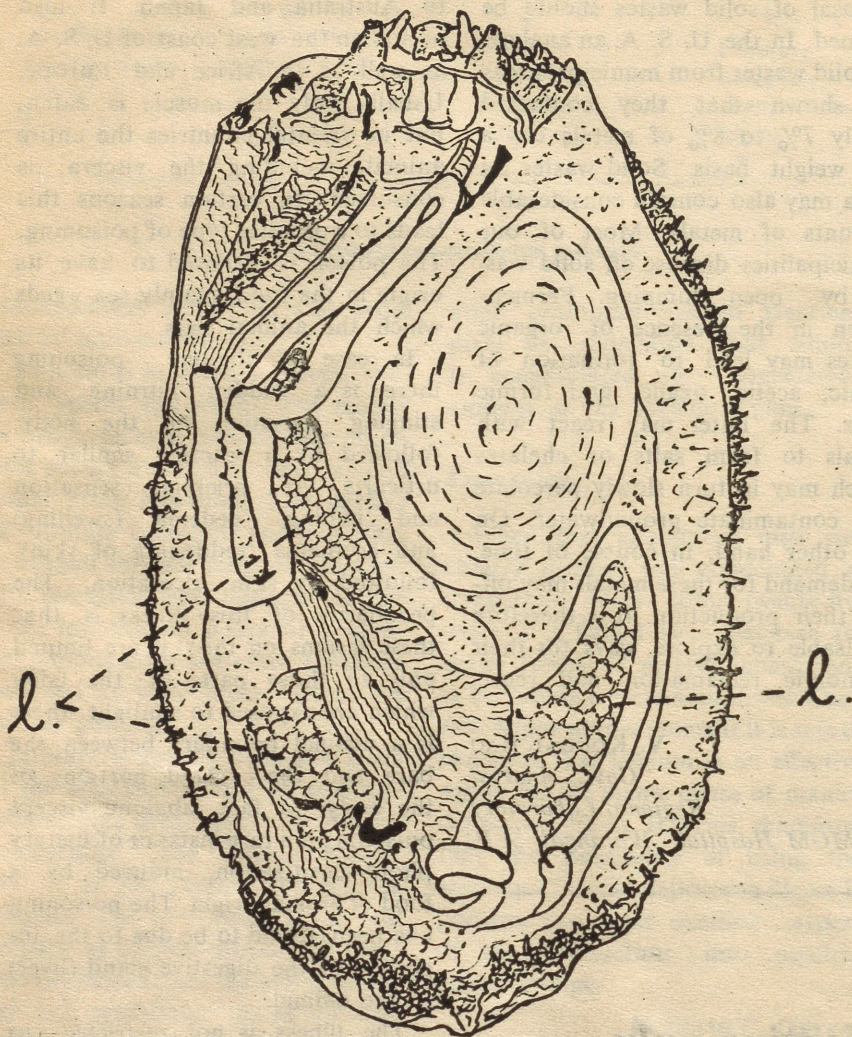


Fig. 1. Dissected abalone showing the large lobulated digestive glands (l)

appetite and weight, and the body temperature was low. The swelling subsided after a few days, but necrosis (decay) developed on the ears, head and back. After three weeks the skin in these regions sloughed off. The naked skin areas subsequently developed a new growth of hair. *Haliotis* liver at a dose exceeding 5 grams per 100 gram-weight of the test animal was sufficient to cause the symptoms.

The toxic principle in the liver of *Haliotis* is stable even after boiling for half an hour or after cold storage (-15° to -20°C) for ten months.

It is insoluble in water, but dissolves in organic solvents such as methanol, ethanol, acetone, ether, chloroform and acetic acid. Liver extracts in these solvents appear dark brownish-green and show intense

red fluorescence under ultra violet light or sunlight. It is a chlorophyll derivative, as indicated by positive Molisch test, and has an intact isocyclic ring.

How does one avoid the unpleasantness of this illness? The best way is to eat only the flesh of the abalone, rejecting the viscera, especially the digestive gland. If one insists on consuming the entire animal, however, one will have to stay in the dark for some time thereafter!

Finally, a few words in favour of the ear-shell. Extracts prepared from the animal have indicated the presence of antibacterial and antiviral substances; they inhibit several gram positive as well as gram negative bacteria, influenza 'A' and polyoma viruses. *Haliotis* may, therefore, yield a powerful anti-biotic too!

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"I'm afraid I shall not be able to come for tomorrow's picnic on the beach. We had abalone liver for dinner tonight."

Photorespiration

IT has been known for a long time that light exerts consider-

able effect on respiration in plants. This is possibly due to a secondary

process of photorespiration, which may be much more intense in some plants than in others. G. Krotkov and his coworkers at Kingston, Canada, observed that respiratory CO_2 evolution is 3 to 5 times higher in the light than in darkness and that there is a post-illumination burst of CO_2 output, especially at higher oxygen concentrations. In 1963, he introduced the term "photorespiration" to differentiate between these apparently separate forms of CO_2 evolution. Photorespiration appears to be maximal in low ambient CO_2 concentration, high O_2 concentration and high temperature.

While evolution of CO_2 is increased in light, oxygen causes a depression of net photosynthesis. The reduction of photosynthesis by atmospheric oxygen was first noticed by O. Warburg, a German scientist, as early as in 1920 and is known as "Warburg effect".

In 1970, Martin Gibbs of U. S. A. observed that glycolate synthesis is enhanced by oxygen. Thus the photorespiratory release of CO_2 is believed to be closely associated with the metabolism of glycolate, a 2-C acid. Israel Zelitch (1974) of New Haven, U. S. A., showed that inhibition of glycolate synthesis in tobacco leaf discs is accompanied by a decrease in the amount of photorespired CO_2 and increase in net CO_2 fixation.

Although glycolate is formed within the chloroplasts, it cannot be further metabolized in chloroplasts. This is due to the fact that chloroplasts do not possess the enzyme glycolate oxidase required for glycolate oxidation. Further degradation of glycolate has been found to take place in a newly discovered cell organelle called "peroxisome" which contains this enzyme abundantly.

Site of photorespiration

Photorespiration or glycolate metabolism involves three cell organel-

les, viz., chloroplast, peroxisome and mitochondrion. But the major site of reactions is in the peroxisome. Peroxisomes are microbodies which are found as subcellular organelles in a wide variety of biological tissues. Biochemical studies carried out by C. De Duve of Belgium and coworkers (1966-1969) have shown that these organelles contain flavin-linked oxidases that produce hydrogen peroxide in liver and kidney cells. The enzyme catalase, which breaks H_2O_2 into $\text{H}_2\text{O} + \frac{1}{2}\text{O}_2$, has also been detected in them. He termed these particles as "peroxisomes" to emphasize their role in hydrogen peroxide metabolism.

N. E. Tolbert (1968-1971) of the Biochemistry Department, Michigan State University, U. S. A., and his associates have investigated microbodies in leaves and called them leaf peroxisomes because they appear similar in many respects to liver peroxisomes. These microbodies range in size from 0.2 to 1.5 microns in diameter and are characterized by a single limiting membrane, a granular matrix and often a dense core or a crystalline inclusion. The microbodies can be isolated from cells by 'sucrose gradient' technique.

Microbodies and mitochondria are two different types of subcellular particles for respiration, but they are readily distinguishable because of their entirely different composition and function. Mitochondrial respiration conserves biochemical energy as ATP, whereas microbody respiration is characterized by flavin oxidases and hydrogen peroxide generation.

Mechanism of photorespiration (Glycolate pathway)

Leaf peroxisomes have been found in photosynthetic tissues of all higher plants, and contain most of the enzymes for the glycolate pathway. The mechanism of glycolate biosynthesis and the nature of the reactions

by which it is metabolized with the associated release of CO_2 are still subjects of conjecture. Several schemes have been suggested (Fig 1.)

P-glycolate is produced in an oxygen-dependent reaction catalysed by RuDP carboxylase. The formation of glycolate from P-glycolate is mediated by the enzyme P-glycolate phosphatase contained in chloroplasts. The oxygenase activity of RuDP-carboxylase has been observed in *Chromatium*, *Rhodospirillum*, *Chlorella* and spinach. The oxygen promotion of photorespiration can be explained by the facts that RuDP-carboxylase activity is inhibited by oxygen and its oxygenase activity is increased by high oxygen concentration; and that the photosynthetic oxygen is not sufficient for glycolate oxidation. The oxygenase activity is also increased by low CO_2 concentration because it inhibits the oxygenase activity. High temperature accelerates the oxygenase activity more than the carboxylase activity. These observations offer possible explanations for the increased photorespiration seen with higher oxygen or lower CO_2 levels or higher temperature. Inhibition of photosynthesis by oxygen (Warburg effect) is, however, relieved with low concentration of ribose-5-phosphate or fructose-1-6-diphosphate but glycolate production remains unaffected in isolated chloroplasts. This suggests that glycolate formation is not a causal factor of Warburg effect. Temperature optima for photorespiration and Warburg effect are also different.

There may be several pathways for further metabolism of glyoxylate. Three decarboxylation pathways in photorespiration have been proposed: (i) in the mitochondrion, (ii) in chloroplast itself, and (iii) in peroxisome. The most widely accepted pathway involves the conversion of glyoxylate to glycine which is then transferred to mitochondrion. In

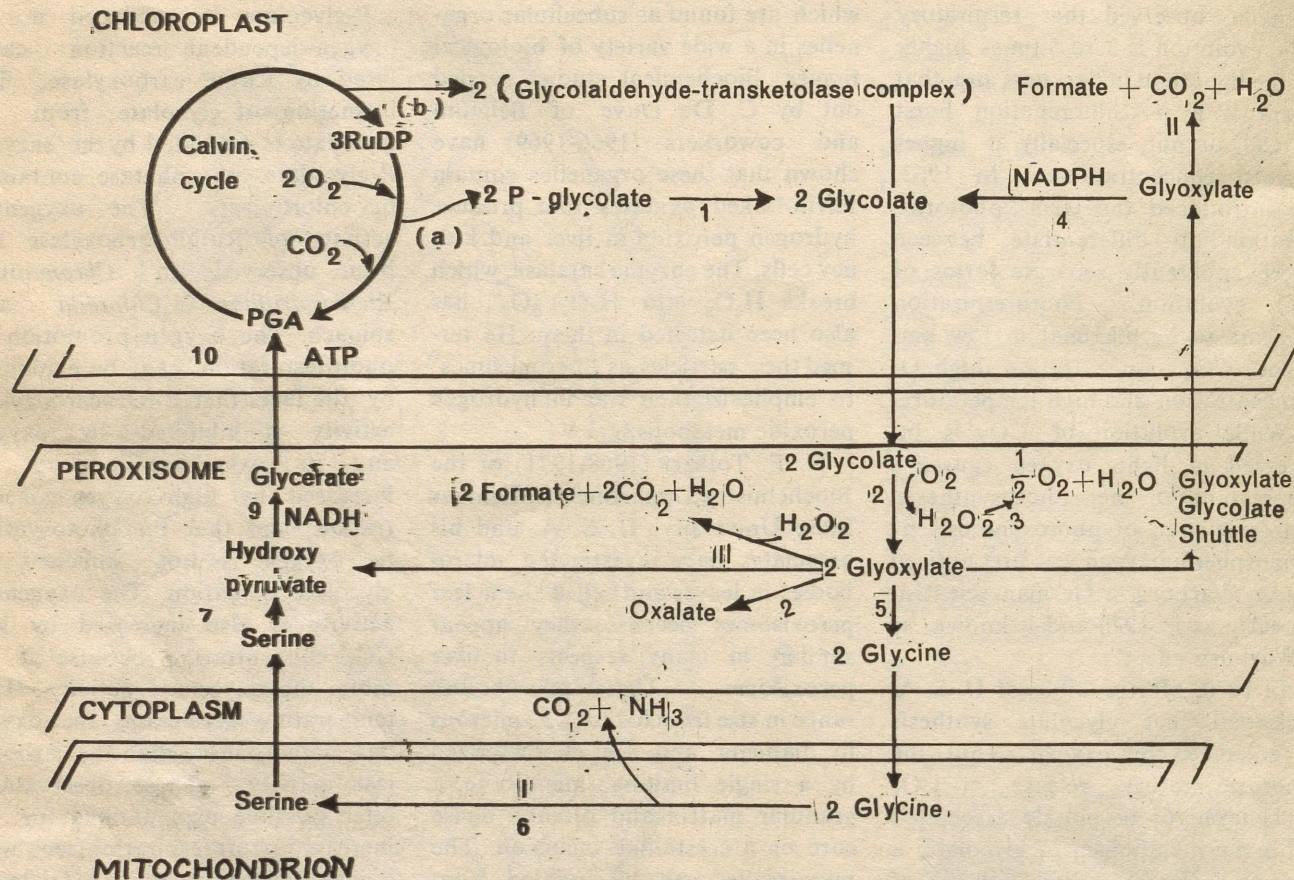


Fig. 1

the mitochondrion two molecules of glycine are converted into one molecule of serine and one of CO₂, which escapes in the cytoplasm. An alternative proposal for glycolate metabolism has been advanced by I. Zelitch (1972) of U.S.A. It states that glyoxylate formed from glycolate oxidation in peroxisomes can be returned to chloroplast and then photo-oxidised (with H₂O₂ as probable oxidant) and decarboxylated to formate and CO₂. Similar peroxidation may also take place in peroxisomes (B. Halliwell and V. S. Butt, 1974). This is more attractive since minimum transfer of metabolites between organelles is neces-

sary. Glycolate metabolism in *Chlorella* and *Anabaena* is different from that in higher plants. In these algae conversion of glycine into serine in mitochondrion has been found to be associated with increase in ATP synthesis. This has led to the proposal of existence of a light-dependent synthesis of ATP in mitochondria.

The serine formed in mitochondrion is returned to peroxisome again and converted into glycerate via hydroxypyruvate. Glycerate formed is presumably transferred to chloroplasts and phosphorylated to PGA by glycerate kinase and ATP (Fig.1).

Significance of photorespiration

In an illuminated leaf, there are two opposing processes: photosynthesis consuming CO₂ and photorespiration generating CO₂. About 50 per cent or more of the CO₂ fixed during photosynthesis subsequently can be evolved via glycolate pathway as photorespiratory CO₂. This means that all the fixed CO₂ would be subsequently photorespired and the plant would cease to grow. It is, however, believed that the amount of RuDP carboxylated in air is at least 4-5 times that oxidised and in that case less than 20 per cent of the fixed CO₂ would be lost due to

photorespiration. This discrepancy points to the fact that alternative pathways of glycolate synthesis and metabolism exist.

Photorespiration must be considered as more than simply an addendum photosynthesis. Some researchers believe photorespiration is a metabolic adjunct to the Calvin cycle. Since oxidation of glycolate is not coupled to ATP synthesis, this process of photorespiration seems doubly wasteful. Why such an apparently wasteful process exists in plants at all is still a puzzling question. Though the positive function of photorespiration re-

mains unknown, the possibilities that it contributes to amino acid biosynthesis, disposal of excess reducing power, and removal of H_2O_2 have been considered by some. To these can be added the possibility of light-dependent ATP synthesis in mitochondria. The fact that plants free of photorespiration have not been found suggests that the process is essential; but it is puzzling why some plants have more of it than others.

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expression depends on the sex of the individual, that is, sex of an individual exerts influence on the expression of these genes.

As an explanation of baldness it has been suggested that an allele (one of the two alternative forms of a gene) H^N in homozygous condition ($H^N H^N$, that is, when the two members of a given pair of alleles are identical) results in normal hair growth in both men and women. Another allele H^B in homozygous condition ($H^B H^B$) produces baldness irrespective of sex of the individuals. H^B in heterozygous condition ($H^N H^B$), however, is dominant in a male but recessive in a female, that is, males $H^N H^B$ heterozygotes are bald but females are normal (Fig. 1). A man, therefore, is bald if he has only one gene for baldness (H^B), whereas a woman must possess two such genes to become bald. This dominant gene can express itself only in the presence of an adequate level of androgenic hormone (male sex hormone). All normal men and women possess sex hormones in their bodies. Males have androgens (or masculinizing hormones) and females have estrogens (feminizing hormones). A male also produces a small amount of estrogen in his body. Similarly, in a female, androgen is produced by the adrenal cortex (the outer part of the adrenal glands). The ovary also produces traces of androgen. Quantitatively, however, females have less androgens than males. The level of the male hormone necessary for the expression of baldness is reached in all normal men but rarely in women. This accounts for the higher incidence of baldness in males than in females.

Some geneticists, however, have suggested that baldness is not actually a sex-influenced but a sex-limited trait (that is, genes responsible for this character are expressed only in one of the two sexes). According

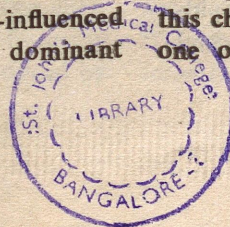
Genetic basis of baldness

A young man may feel himself proud of having thick, dark hair on his head when he finds that one of his friends has lost almost all the hair from his head. Commonly we see that only men are bald. However, bald women are not uncommon. The advantage of females over males in this case is that the genetic mechanism operating in the former helps them to hide it out.

Several environmental factors are often mentioned as possible causes of baldness. Infectious diseases such as syphilis and specific abnormalities of thyroid metabolism may cause baldness. Exposure to high energy radiations may also cause loss of hair in both sexes. But the most common, premature or "pattern baldness", occurs in healthy individuals. Studies on distribution of the character in many family groups exhibit that the character is transmitted from parents to their sons and daughters. A hereditary basis for baldness is therefore pos-

sible. The hereditary basis of baldness was indicated long ago by Greek philosophers. Hippocrates, the father of medicine, drew attention to the recurrence of bald-headedness in certain family groups.

Apparently it seems that baldness is a recessive, sex-linked character like colour blindness, because it occurs more frequently in males than in females. One of the characteristics of sex-linked inheritance is the absence of male-to-male, that is, father-to-son transmission. But bald fathers often transmit the character to about half of their sons and to a few of their daughters. So, the inheritance of baldness does not follow the pattern of sex-linked genes. Investigations on the mode of inheritance of this trait, however, revealed that it is controlled by autosomal genes (genes situated on chromosomes other than sex chromosomes) known as sex-influenced genes. Sex-influenced genes are those whose dominant



Hedgehog and toad poison







GENOTYPE	PHENOTYPE	
	MALE	FEMALE
$H^N H^N$		
$H^N H^B$		
$H^B H^B$		

Fig. 1. Baldness in human males and females: genotypes and the corresponding phenotypes

to this view, baldness, like the development of beards and moustaches, is a male-limited trait and remains unexpressed in all women having normal levels of sex hormones in their body. Occasionally females become bald if they produce a masculinizing hormone in their body. If the quantity of this hormone reaches a particular level, the genes for baldness can act and result in baldness.

The phenotypic expression of baldness varies from one person to another. Baldness may be slight or extreme, develop on the forehead or on the tophead and may appear early or late in life. Some persons become bald prematurely, before the age of thirty and others develop it later.

If a man, heterozygous for baldness ($H^N H^B$), marries a normal

woman ($H^N H^N$), about half of their sons may be expected to become bald but all their daughters will have normal hair. On the contrary, when a bald woman ($H^B H^B$) marries a normal man ($H^N H^N$), all their sons are expected to be bald but all the daughters will be normal. If both parents are bald, all their children may be bald, or all sons and some daughters are affected.

So, if a man begins to lose hair from his head, he may consult a physician. Hair growth may be restored if the cause is environmental or physiological. If the cause is genetic, there seems to be no remedy.

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THE use of poisons and toxic substances on the tip of arrows and other sharp weapons is an old practice that has been followed by primitive man for ages. Even now, tribals and aborigines in many parts of the world use this method. Their main purpose is obviously to make the weapon—arrow or spear—more effective in killing or maiming the victim. In a recent issue of *Nature* (268,627, 1977), an American biologist, Edmund Brodie, reports about a similar use of poisonous substances by hedgehogs, the insectivorous animals with sharp spines on the back. These animals roll into a spiny ball when frightened, an action which normally turns the attacker away. Brodie observed that hedgehogs use toad skin poison to anoint their own spines, possibly as an added protection against predators.

Toads (*Bufo*) are normally found in natural habitats of the hedgehog and are commonly eaten by the latter. When hedgehogs attack toads, they first bite and chew the parotid glands (which contain the greatest concentration of skin toxins), and

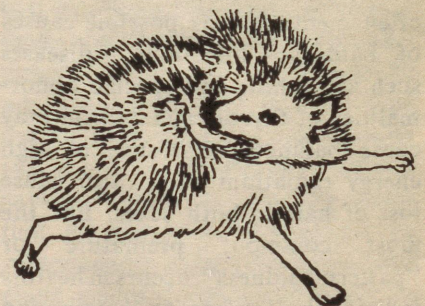


Fig. 1. Adult hedgehog anointing its spines with the froth of saliva and toad skin secretion after chewing a toad



Fig. 2. A hedgehog rubbing a whole toad (*Bufo*) against its spines

then spread the resultant frothy mixture of the toxin and saliva over the spines (Fig. 1). Sometimes the hedgehog holds the toad in its mouth and rubs its skin over the spines (Fig. 2). Young hedgehogs have been observed to lick the frothy mixture from their mother's spines and apply it to their own.

In tests with volunteers, it was found that the toxin-coated spines produced immediate intense local burning sensation when jabbed into the skin. Uncoated spines caused no pain other than the mechanical pain of puncture.

BIMAN BASU

the swimming actions of the animal and the receptive centre for the echo seems to be located in the first pair of antenna on its head.

The freshwater beetle *Gyrinus* 'whirls' on the water surface to survey the water. The sound produced by its swimming movements is reflected from obstacles and picked up by its elaborate antennae which form a fringe of sensory hairs on a pedicel. Its ability to avoid obstacles is far less skilful in distilled water, while it is enhanced in stagnant water covered by dust particles and thin films of oily substances.

Several 'Echo fishes' have been discovered in the ocean. Echos are of the order of 500 c/s. In contrast

Echolocation in animals

ALL animals have their own signals for communication with other members of the group. A particular type of acoustic signal is associated with a particular type of action. For example, the sound made during courtship differs from that made in anger or in response to an enemy. Most of these sounds are audible because we can hear sounds between the frequency range of 30 cycles per second to 20,000 cycles per second. Certain animals use sounds of higher frequency (which are inaudible to us) for locating objects. For this the animal emits sound waves which are reflected when they strike an obstacle. The animal hears the sound waves reflected from the object and is able to judge its distance. This phenomenon of locating objects from the echo of the sound reflected from an object is known as 'Echolocation'.

Echolocation has been observed in some crustaceans and insects, and in many fishes, birds, bats and whales. In most cases this fascinating activity is not aided by

an animal's visual sense. Echolocation has however attained perfection in just two animals—bats and dolphins. Bats deserve more credit for their historic significance, for the impetus that they have given to this branch of study.

Aquatic echolocation

Contrary to the well-known saying, "silent as a fish" fishes are not all that silent. We do not hear the noises of fish and other animals under water because most part of the sound is reflected back from the surface into water and hardly any reaches our ears.

Object location in arthropods (animals with jointed appendages) by echo-sounding is not acoustic but is connected with a tactile sense. However, there is a certain analogy between this system and one of the true acoustic nature.

Sound orientation in *Mixodiaptomus laciniatus*, a fresh water crustacea, has been proposed by many authorities. Sound is produced by

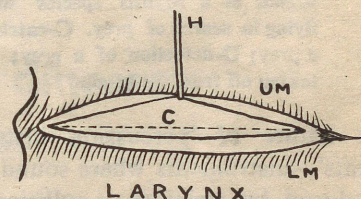


Fig. 1. Membranes covering one side of the laryngeal cavity of the bat *Eptesicus fuscus*. C-cavity; H-hook holding up the upper membrane (UM); LM-lower membrane

to birds and mammals, where variations in pitch play an important role, the different pitches (or spectral composition) of the sounds in fishes remain constant and only the rhythm is variable. However, in minnows—the spectrum ranges from 85 c/s to 11,000 c/s.

All sound-producing organs found so far in fishes are more of



"Daddy, snakes hear through eyes and bats have vision through their ears?"
"The former is a saying dear, but the latter is echolocation."

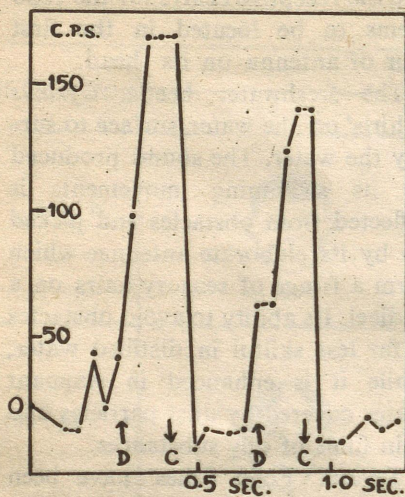


Fig. 2. Rate of emission of the orientation sounds of a *Myotis* species when flying in search of prey. C-catching a prey; D-detection of a prey; O-taking off from the ground

the nature of 'percussion instruments'—instruments where sound is produced by striking or collisions. The swim bladder in fishes is an apparatus of hydrostatic function, i.e., it helps the fish to maintain equilibrium while the latter orients itself at different depths inside water. In some fishes it acts as

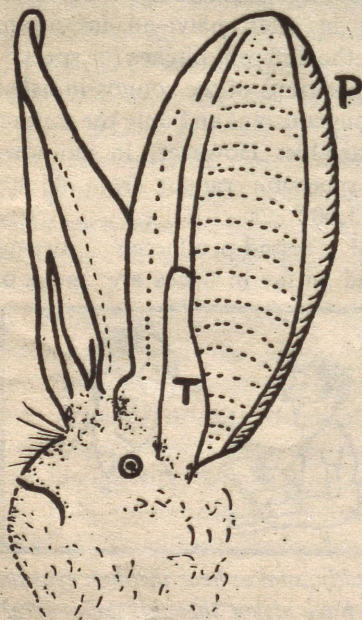


Fig. 3. Head of the long eared bat *Plecotus auritus*. P-pinna; T-tragus.

a resonator, apparently involved in both the transmission and reception of sound signals. Various forms of drum muscles are attached to the outside of the swim bladder which make it vibrate.

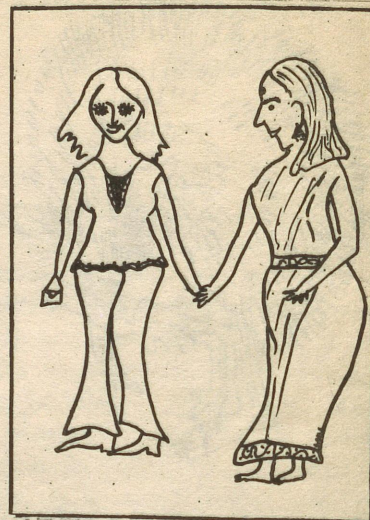
Whales and dolphins, apart from possessing a conversational sound vocabulary, make cries which are evidently intended for echolocation. However, in "dolphin territories" the dolphins can swim very fast silently as they are well used to it. Dolphins can swim at speeds greater than 38 km per hour, and locate objects up to 36 m away, even in turbid water, through echolocation.

A controversy remains as to how the cetaceans produce sounds in the absence of true vocal cords. Some investigators think that they use their nostrils and air sacs of the respiratory tube; others are of the opinion that the throat (special growths of the inner wall of the larynx) is used. However, the cetaceans, more specially odontoceti, have well developed auditory organs of great sensitivity and can locate the source in water in a way humans do in the air.

Aerial echolocation

The moth, *Prodentia evidania*, in addition to the fundamental frequency of the wing beats, which is too low to stimulate tympanic organ, emits a pulse with a frequency close to 15 kc/s. This is usually meant for echolocation.

The 'oil bird' or guacharo (*Startonis*) is a cave dweller of Peru, Venezuela, Guyana and Trinidad Island. It displays a double system of orientation, both visual and acoustic. The acoustic orientation is apparently utilized in the dark. These sounds have a frequency range of 6.1 kc/s to 8.75 kc/s and each click lasts for 1 m/sec to 1.5m/sec. The clicks are not emitted regularly, but in 'bursts'.



"The other day when there was a load-shedding I was trying to echolocate him but I located my mummy in stead."

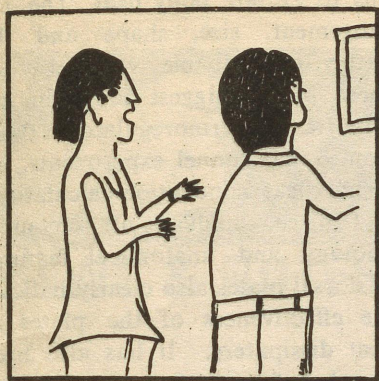
The Salariganes (*Collocalia*), birds of South Asia, emit clicks whose purpose, nature and duration are similar to those of *Startonis*. However, the clicks become more intense when the bird flies towards the darkest part of the cave but they virtually stop as it flies towards light.

Other birds like swifts of Europe and the common night hawks echolocate their insect prey by emitting sounds composed of a series of short pulses.

Rats probe their environment by emitting acoustic signals. When they do not hear an echo, they know the presence of a hole in front. The squeals of laboratory rats, *Rattus norvegicus*, cover frequencies from 19 kc/s to 29 kc/s which last for two seconds. Similar ultrasonic components upto 54 kc/s have been recorded in the squeals of guinea pigs, *Cavia cobaya*, but their whistles are within the audible range.

Bats were the first animals to attract attention of scientists to the existence of echolocation. Different kinds of bats use different mechanisms of echolocation.

The source of the emitted sound in bats is located in the respiratory



“How is that you don't get caught by your parents while talking to her through this window?”

We communicate through inaudible ultrasounds.

tract. The rhinolophid bats (horse-shoe bats) emit and control the focus of the sound through the nasal folds and thus have the advantage of feeding without any disruption in ultra-sound production. In the vespertilionid bats the sound emitted is partly vocal and partly nasal.

To avoid confusion, the ear is plugged with a muscle just at the time a cry is produced.

Analysis shows that bats make three kinds of noises—first, an audible cry at a frequency of about 7,000 c/s; secondly, a supersonic cry which is loudest at 45,000 c/s to 55,000 c/s; and thirdly, an inaudible click. The second is actually responsible for the bat's ability to locate obstacles.

The intensity of the echo is much lower than that of the original sound because of spreading loss and physical absorption in the air. But bats can evaluate an echo even if the sound pressure is reduced by 1/1000th part of the original signal. Moreover, according to 'Doppler-Fizeau Effect', a sound appears to have a slightly higher frequency to a listener moving towards the sound-reflecting surface. Bats measure the distance to an object in terms of the time lag between their outgoing orientation sounds and the returning

echo, both of which are coded in terms of neuro-responses.

Bats can pass through passages far narrower than any birds of the same wing-spread can get through. They can skilfully avoid wires of 1 mm in diameter hung vertically at 30 cm intervals in a room. Certain fish-eating bats echolocate fish close to the surface. Echolocation aids a great deal in bat's homing habit.

In spite of their wonderful feat of echolocation, bats at times do make errors when they are tired or are not fully awakened, or are careless and over confident. Protective behaviour of insects (ca-

mouflage within thick hairy covering to absorb the ultra-sound and preventing echo production or by developing ultra-sensitive hearing organ) and confusing elements like echoes from the surrounding objects, cries of other bats and ultrasonic pulses generated by insects also add to errors in echolocation in bats. Laboratory experiments have however shown that jamming the bat's sonar system is extremely difficult.

LALA A. K. SINGH

B. K. BEHURA

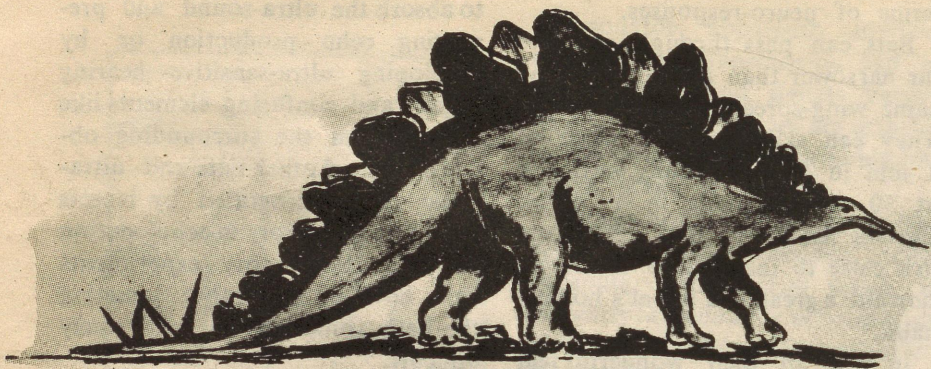
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Mystery of dinosaur plates

OF all the reptiles who ruled the earth through one hundred million years of mesozoic history, stegosaurus or plated dinosaurs were perhaps the strongest in appearance. Being one of the earliest members of the known ornithischian reptiles (a primitive reptilian stock), stegosaurus were remarkable for a number of peculiar features of their own which were not shared by any other members of the group. These so-called 'double-brained' creatures were distinguishable from their close relatives by the presence of a series of raised plate-like structures on the dorsal side of the body (Fig. 1). For the last several years, both biologists and paleontologists have been trying to establish different physiological aspects of the now extinct stegosaurus. The study of the morphology and the preserved arrangement has indicated that in living condition the plates of stegosaurus stood upright near the

dorsal midline of the body; the edges of the plates were thin but the bases were thick and embedded in the back. It has also been suspected from the fossil remains, that in living animals these plates were covered by a thin horny layer. It is, however, interesting that in contrast to the usual bilateral symmetry of reptiles, the dorsal plates of stegosaurus were arranged in an alternating or staggered manner instead of being paired. On the tail, on the other hand, there were four long pointed bony spikes which, unlike the dorsal plates, were typically paired and symmetrical in arrangement (Fig. 1). There is a general agreement among the paleontologists and biologists regarding the function of the tail spikes as an organ of offense, but the function of the dorsal plates is still a matter of dispute.

C.W. Gilmour of the National Museum of United States regards



these plates as additional defensive devices used to threaten enemies. Dr. L. Davitashvili of the USSR Academy of Sciences, Moscow however discards the idea of Gilmour and advocates that the plates of stegosaurus were actually used for sexual display during courtship and

reproduction.

A group of American biologists, Drs. James Farlow, Carl Thompson and Daniel Rosener of Yale University, USA, have suggested in a recent communication (*Science* 192, 1123, 1976) that the plates of stegosaurus were actually used as

fins to radiate body heat. The arrangement, size, shape and the nature of probable vascularity of these plates suggest for them an important thermoregulatory function. Wind tunnel experiments, internal heat conduction calculations and direct analysis of the morphology and anatomical features of dorsal plates also clearly indicate the effectiveness of the plates as heat dissipaters. It has also been revealed from other experimental studies that the capacity of heat dissipation was controlled through input blood flow rate, temperature and body orientation of the animal with respect to the wind.

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LETTERS (Continued from page 616)

folia, 3.04 mm for Poplar and 8.87 mm for Chir.

However, further experiments are being conducted at the F.R.I. to study the water consumption behaviour of *E. tereticornis*. Also, a 5th Five-Year Plan scheme to establish

four Environmental Research Stations at Srinagar (J & K), Simla (H.P.), Kurseong (W.B.) and Ootacamund (T.N.) has been sanctioned. These research stations would *inter alia*, study the effect of forest cover on ground water sup-

plies. All these studies would in due course dispel the doubts regarding the suitability of the species.

Chief Publicity & Literature Officer
FRI & Colleges
Dehra Dun

ORIGIN OF LIFE (Continued from page 620)

cause it is "a classic viewpoint but one which is far from satisfactory for numerous biologists". All the more so, because Schoffeniel's book provides none which is more satisfactory. All in all, it seems to me that Schoffeniel's denigration of Monod's

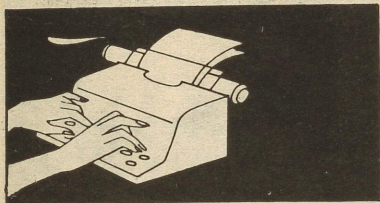
"classic" viewpoint is like Don Quixote's tilts at the windmills. They do not hurt the windmills but they do amuse the onlooker no end.

Further reading

1. Monod, Jaques, *Chance and*

Necessity, Vintage Books, New York.

2. Schoffeniels, E., *Anti-Chance: A Reply to Monod's Chance and Necessity*, Pergamon Press, Oxford, U.K.



NEWS & NOTES

Prof A. V. Hill —a tribute

PROFESSOR Archibald Vivian Hill, who died on June 3 this year at the age of 90, was described by *The Times* as "One of the foremost scientists of his time." The first scientist from Britain to have been awarded the Nobel Prize in Physiology and Medicine in the year 1923, along with Otto Meyerhof, Professor Hill is known primarily as a biologist. But few know that he was a multi-faceted genius equally at home with mathematics or physical chemistry or instrument design. Professor Hill was by no means a cloistered scholar or a narrow specialist. A man of wide interests, Prof. Hill was a Member of Parliament from the University of Cambridge, an adviser to the Government on subjects as diverse as medical education and defence from air-attack, and was "a fine athlete, a genial host and a convincing speaker and writer."

Born on September 26, 1886, he went to Trinity College, Cambridge in 1905 and won the 3rd Wrangler position in the Tripos of 1907. Then he faced the problem of choosing his field, whether to pursue further study in mathematics or to turn to another subject where he could utilise his thorough mathematical training.

Taking the advice of his tutor

Sir Walter Fletcher, Hill decided to shift his interest from mathematics to physiology. But he did not sacrifice mathematics, instead, after obtaining a First in the Natural Sciences Tripos in 1910, he tried to combine the two. He turned to "various problems in physiology which seemed ripe for mathematical treatment."

His beginning with a modification of Nernst's theory of excitation established him as a mathematician ready to consider the problems of experimental biology. In fact, this field was very much in need of a person with a solid foundation in mathematics. As per the suggestion of Langley, a Professor of Physiology, Hill took up the programme "to investigate the phenomenon of heat production of muscles during activity". After visiting several laboratories in Germany where muscle physiology was being studied, he returned in 1911 to begin research on heat evolution in muscle and nerve, his most important work that earned him the Nobel Prize and immortalised his name in the annals of biological sciences.

With the help of extremely sensitive instruments he succeeded in the difficult task "to separate the different phases in the energy cycle of muscular contraction and to relate them to the chemical events, some of which had been studied in Cambridge by Hopkins and Fletcher". But measuring a scientist of Hill's stature by this work alone would be unjust. In fact, Professor Hill's contribution to the development of biology was tremendous and this was so because his researches clearly showed how much could be gained with the proper use of techniques and concepts of the more exact sciences.

Though Hill was, in a sense, a public man by virtue of his holding important positions on national and international committees, his output in research was simply prolific

and there is no denying the fact that his leadership in organising scientific research "helped to establish the subject of biophysics as ripe for development, with important aims and a territory of its own."

During the First World War, Hill led the team which studied scientifically the anti-aircraft gunnery and this early exposure to the field of operational research stood him in good stead and equipped him better in introducing scientific techniques during the Second World War. After the First World War, Hill was appointed Professor of Physiology at Manchester and in 1923 as Professor at University College, London. He became Foulerton Professor of the Royal Society in 1926 and remained in that chair for about quarter of a century before he retired in 1951.

An Editor of the distinguished *Journal of Physiology*, Professor Hill became the Secretary of Royal Society. He had been for five years (1940-1945) a Member of Parliament from the University of Cambridge. An Independent Conservative in the House of Commons, Prof. Hill could impress all and sundry by his sincerity and expert knowledge. In order to reorganise his laboratory he retired from Parliament which was very much regretted. But his laboratory was soon re-established as a major centre of biophysical research, attracting some of the finest young talents from all over the world.

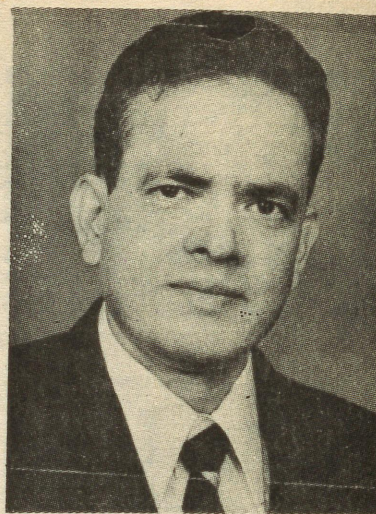
Prof. Hill spent his whole life fighting for his cause—science and scientists. His uncommon common sense and a truly liberal outlook made him the fittest person for heading scientific communities dealing with national and international problems. His role in rescuing scientists, persecuted for their race or opinions, in Germany would be remembered for long. As Foreign Secretary of the Royal Society and Secretary-General of the Council of Scientific Unions, Prof. Hill rendered

yeoman service in reviving scientific activity in Europe after the Second World War. An Honorary Fellow of King's College and of Trinity College, Cambridge, and honoured all over the world, Professor Hill was President of the British Association in 1952.

Known as "AV" to his colleagues and friends, Professor Hill was a gentle, warm person. He married Margaret Keynes, sister

of the famous economist, Lord Keynes, in 1913. A well-wisher of India, Professor Hill was indeed a citizen of the world and his death symbolised the death of a scientist who was more than just a scientist.

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Dr. Ghatak

An Interview

Dr. U.R. Ghatak

"IN our country, a researcher carries forth his work only because of his aptitude for research. Otherwise, other prospects of his life are not that attractive," says Dr. Usha Ranjan Ghatak, the 1974 S.S. Bhatnagar Award winner in Chemical Sciences. He is very much correct, though on the face of it it may not look apparent. To put it frankly, this is one reason why our country produces time and again some brilliant scientists while the average level of scientific temper remains the same low. That also explains why there are only a few pockets of research institutes and schools where brilliant work is on. Those who are totally dedicated and fortuitously get proper guidance and facilities go ahead, while others vegetate.

Still, according to Dr. Ghatak, "most of our younger scientists are doing what they could. But to maintain a high standard of research it is necessary to have the minimal facilities. Otherwise, one loses in the international competition only because of dearth of resources. There is, then, all the greater need for a hard competi-

tion between researchers in the country."

Born on February 26, 1931, in Brahmanbaria (now Bangla Desh), Dr. Ghatak's early life was one of struggle and hardship. During his college days he had to earn for his education and maintenance either through private tuition or part-time teaching. In 1947 after Bengal partition, his family migrated to Calcutta where he did his B.Sc. (Hons) and M.Sc. In 1957 he did Ph.D. from the Indian Association for the Cultivation of Science, Calcutta, and since then he has been working there. He has done research at various foreign universities and is also a visiting scientist.

Dr. Ghatak has made outstanding contribution to methods for stereochemically controlled organic

synthesis, particularly in fields of complex diterpenoids and bridged-ring polycyclic compounds. These compounds are related to some physiologically active natural products such as the important plant growth regulating hormones—gibberellins and the tri- and pentacyclic diterpene alkaloids. An interesting bridged-ring hydrocarbon has also been synthesised by his group which shows a strong pheromone activity towards *Rhinoceros* beetle, a pest of coconut palm, in olfactometer tests.

His work has led to a deeper understanding of conformational and steric factors of organic molecules which control bond formations in organic synthesis. It has also focussed on new reactions that form such bonds in novel ways. Many of the methodologies developed in his work have both academic and applied interest.

DILIP M. SALWI

All India Seminar on Ichthyology

THE first All India Seminar on Ichthyology (AISI) was held from May 23 to 26, 1977 at Zoology Re-

search Laboratories, M.M. College, Meerut, under the auspices of University Grants Commission. Seventy

four ichthyologists from different states attended the seminar.

Dr. A. G. K. Menon, President, Ichthyological Society of India and Deputy Director, Zoological Survey of India, Madras, expressed the need of fundamental knowledge of taxonomy for the young ichthyologists of the country. He proposed to provide facilities of training programmes, and workshops in taxonomy at the Zoological Survey of India, Madras. Dr. V. P. Agarwal, Principal, DAV College, Muzaffarnagar emphasized the necessity of fish research, pertinent to the immediate requirements of the

masses and maintained that there should be a dynamic coordination between scientists and industrialists.

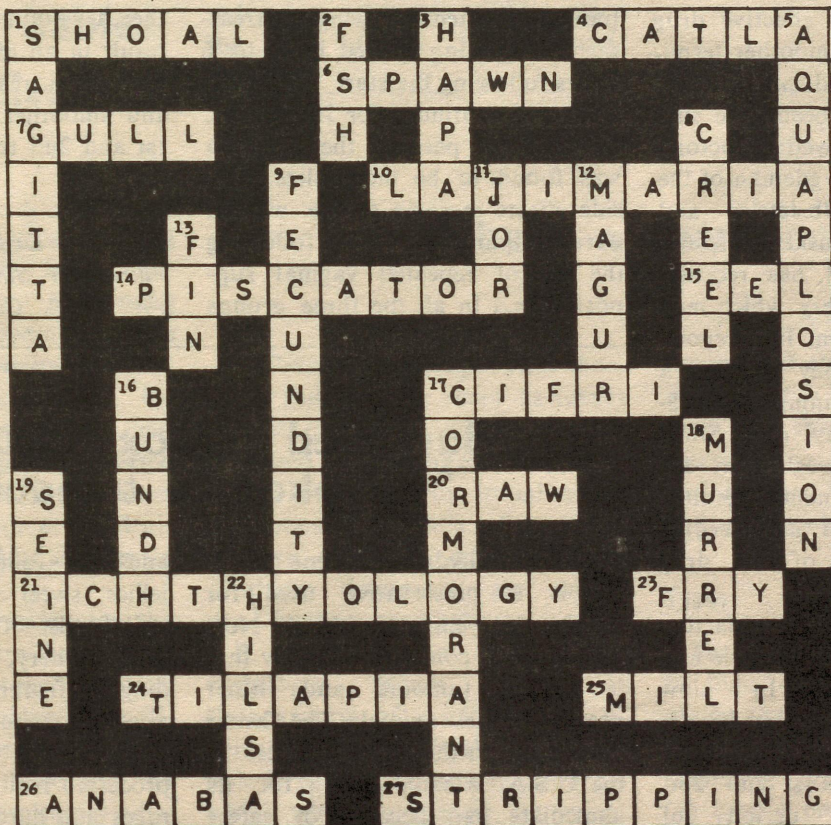
O. P. SAXENA
Head of Deptt.

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M. M. College, Modinagar (U.P.)

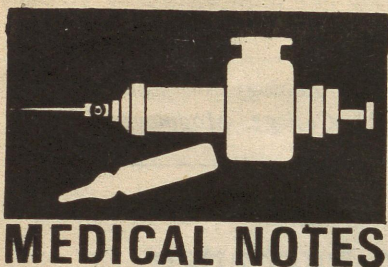
Symposium on Ion-Exchange

THE Central Salt and Marine Chemicals Research Institute, Bhavnagar, is organizing a symposium on Ion-Exchange in Feb. 1978. It will be a two-day symposium and will include about 8 topics covering a wide range of interests in ion-

exchange. For details, write to Dr. D. R. Baxi/Dr. G. T. Gadre, Secretaries, Symposium on Ion-exchange, Central Salt & Marine Chemicals Research Institute, Bhavnagar-364002, Gujarat.



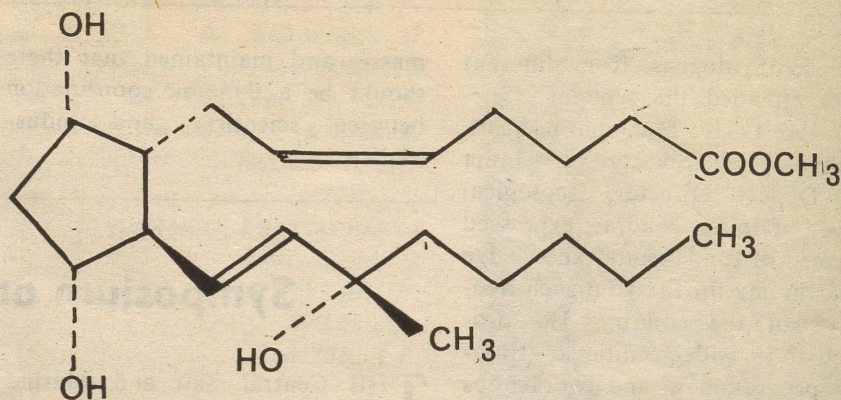
Solution to crossword puzzle published in S.R., September 77



A new drug for abortion

FAMILY welfare and family planning departments throughout the world have been in frantic search of a safe and effective drug capable of causing smoother termination of unwanted pregnancies. But so far there has been little success. A group of six Swedish doctors, headed by Dr. M. Bygdeman of the Department of Obstetrics and Gynecology, Karolinska Hospital, Stockholm (Sweden), has recently announced a discovery which may revolutionise abortion. In a report, published in 1976 they say that a vaginal device containing 15(S) 15-methyl-PGF_{2α} methyl ester when applied to women even in an advanced stage of pregnancy, resulted in successful abortion; and bleeding started within hours of the drug application.

Prostaglandins are the factors which stimulate smooth muscle and reduced blood pressure. In a slow releasing vaginal device, Dr. Bygdeman's group administered the drug to 30 women in the 1st and 2nd trimester (3-months period) of pregnancy. Ten of them were in the early stages (31-49 days following the last menstrual period) and the other 20 in the 10th to 20th week of pregnancy. The results were compared with those given repeated vaginal administration of triglyceride suppositories containing



prostaglandin—50 patients in early pregnancy and 30 patients in the 2nd trimester of pregnancy.

The total mean dose of the prostaglandin given to these two groups was 3.9 and 7.8 mg respectively. All the 60 early pregnant patients aborted following the treatment. Bleeding started in 3 to 6 hours following the start of treatment and continued for 10-14 days. In only two patients the abortion was found to be incomplete. The side effects in some of the women were comparable to those following the use of repeated vaginal suppositories. In all the three groups

of patients in the late 1st and 2nd trimester of pregnancy, treatment resulted in abortion within 24 hours in 90% of the women. In all the three groups of patients the side effects were within acceptable and safe levels. It is hoped that further development of the device may result in an effective vaginal administration treatment for the quick and smoother termination of both 1st and 2nd trimester pregnancies.

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Butylated hydroxy toluene is linked to tumour

BUTYLATE hydroxy toluene (BHT) is a preservative used for nearly 30 years in foods. Now evidence has come up to show that it causes tumours and other problems in test animals. The Center for Science in the Public Interest in the U.S.A. is campaigning for its immediate ban because of safety questions, and of its unnecessary addition as a preservative in foods. Americans each year consume about a million pounds of BHT, which was approved by the U.S. Food and Drug Administration (FDA) for use in foods in 1954. It is used to retard rancidity. Its heaviest use is in fats

and oils followed by jams and jellies, sweet sauce, nut products, milk foods, soft candy, baked goods, confectionery, frosting, gelatin puddings, frozen dairy products, gravies, alcoholic beverages, chewing gum, soups, processed vegetables, processed fruits, nonalcoholic beverages and hard candy. FDA earlier this year proposed that BHT be dropped from the approved list of food additives but be allowed until further conclusive studies.

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FOR HER

Caesarean babies and lung diseases

THERE has been a significant increase in doctor-caused lung disorders among new borns because obstetricians are performing too many caesarean operations. The number has risen astronomically, with caesareans accounting for more than 20 per cent of all deliveries in some hospitals, reported Dr. L. Gluck, Head of Neonatal and Perinatal Medicine at the University of California Medical Centre in San Diego.

A caesarean operation involves the removal of an unborn baby from the uterus by a surgical incision through the abdominal wall. The ill-advised timing of caesarean operations is threatening to become the leading cause of respiratory distress syndrome (RDS) or hyaline membrane disease in infants. Both of these lung disorders are fatal and often leave the infant with permanent lung damage. The problem has arisen by the widespread use of new foetal monitoring equipment. Using sensors

attached to the unborn infant, this equipment is intended to detect foetuses that run into serious troubles inside the uterus. Usually when oxygen supply to foetus is cut off, a caesarean operation can often save it. Some physicians are, however, using the foetal heart-monitoring equipment without knowing how to interpret the information. They misinterpret readings and order a caesarean when it is not needed. When this happens, an infant may be removed from the uterus too early when his lungs are still premature. Such a stress can cause lung disorders. In America, caesarean operations nearly doubled from 1967, when they accounted for 5.1 per cent of all deliveries, through 1974 when the rate rose to 9.8% accord-

ing to the commission on Professional & Hospital Activities in Ann Arbor, Michigan. Studies show that 9 per cent of the infants born through caesarean operations have premature lungs, compared to a premature lung rate of 6-7 per cent for normal deliveries.

Caesarean operations have become excessive in some hospitals. A report claims rates as high as 26 per cent. Hasty caesareans can be avoided with proper tests to measure the maturity of the infant's lungs while it is still in the uterus. These tests measure chemicals, such as lecithin and sphingomyelin, which increase as lungs mature.

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What's a shampoo ?

THE use of shampoos has changed over the years as totally as their composition. Formerly soap was used for washing the hair, today it is shampoo. In initial stages shampoos were made of soaps or mixture of soaps, whereas today synthetic detergents are mostly used in their preparation.

R. G. Harry, an English cosmetologist, defines shampoo as "preparation of a surfactant (i.e., surface-active material) in a suitable form—liquid, solid or powder—which when used under the conditions specified will remove surface grease, dirt and skin debris from the hair shaft and scalp without affecting adversely the hair scalp of health of the user." Scientists have observed that a good shampoo should cleanse hair and scalp thoroughly without stinging or irri-

tation, and should not remove too much of the natural oil from the scalp. A shampoo is not only a detergent but a cosmetic as well, and it must impart lustre, beauty and manageability to hair.

Types

Shampoos are classified according to their appearance, or in some cases, their special ingredients or properties. They may be of the following types (i) Liquid clear, (ii) Liquid cream or cream lotion, (iii) Cream paste, (iv) Egg, (v) Herbal, (vi) Dry, (vii) Liquid dry, (viii) Colour, and (ix) Aerosol.

In addition, one or several of these types may be based on special raw materials or have special additives that would make them anti-septic or antidandruff.

Raw materials

Soaps are generally considered as the salts of fatty acids. They are mostly made from animal and vegetable fats and oils. Oils which contain primarily the shorter chain fatty acids yield better foaming soaps. These shorter chain acids contain 10 to 12 carbon atoms in a straight chain and usually work best at low temperatures. The soaps from fatty acids with somewhat longer chains (13 to 15 carbon atoms) are excellent cleaners, particularly in warm water and those from long chain fatty acids (16 to 18 carbon atoms) are most effective at 70 °C and higher.

The vegetable oils are glycerides of fatty acids, ranging from caproic, with six carbon atoms, to behenic with 22 carbon atoms in the chain. In fatty acids with less than 10 carbon atoms in the chain, salts too are soluble to show an appreciable detergency, while the soaps of fatty acids with more than 20 carbon atoms are too insoluble to act effectively at normal temperature.

Olive oil soaps have long been considered the best for shampoos. As the soap made from olive oil is essentially sodium oleate, such a shampoo is not good for lather formation. In many olive oil shampoos some free oil is left in the

shampoo to contribute a conditioning effect to the hair.

Soaps from coconut oils have always been noted for their excellent lather. They consist chiefly of sodium laurate and sodium myristate. Some claim that soaps from coconut oil are more drying and that they may be irritating to the skin, perhaps due to their caprylic and capric acids content.

The shampoo obtained from a single fatty acid is rarely satisfactory. A good shampoo requires a number of properties and no single acid contributes the wide range of characteristics needed. In recent years, triethanolamine soaps have come into popular use.

Shampoo additives

An increasing number of compounds have been developed which are not in themselves shampoos but which contribute to the performance or acceptance of shampoos. They may contribute to the foam, feel, consistency or finish imparted by the shampoo.

Finishing agents. The difference between an ordinary detergent and a shampoo lies in the finishing action of a shampoo. Finishing agents have been of great importance in increasing the use and acceptance of synthetic shampoos.

In the early soap shampoos, the unsaponified vegetable oils contributed to conditioning action. More recently, lanolin and its derivatives have been promoted as finishing agents in spite of the fact that they cut foaming and scouring action. Mineral oil is used only occasionally as it is difficult to wash it out from hair. Esters such as isopropyl myristate and butyl palmitate, and particularly the mono and diethanolamides of fatty acids are used as finishing agents.

Conditioning agents. Finishing agents and conditioning agents are closely related. Glycerol, propylene glycol, sorbitol and urea help retain moisture and delay its evaporation. Their addition in shampoo formulation softens the hair and helps retain moisture in them.

Preservatives

Then there is the problem of protecting the shampoo from deterioration by bacterial or mold action. This necessitates the selection of a preservative from formaldehyde, methyl, propyl or butyl-hydroxy benzoates, alkyl anisoles, hydroxyquinolene, dehydro acetic acid salts and alkyl cresols.

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SCIENCE FOR THE YOUNG

Birds and bird-song

NEXT to human beings, birds are the only vertebrates which make a variety of sounds and sing songs. Other vertebrates, such as mammals, reptiles, fishes and amphibians are generally silent. The tiger can only roar; some snakes can hiss; frogs and toads can make noise during breeding season and a few fishes can grunt. Most invertebrates, say, insects, are instrumentalist in that they produce sound by rubbing together modified appendages of the body. These vocal or non-vocal sounds do not, however, equal the melodious songs of the birds.

As in humans, so in birds, all sounds are not songs. The vocal sounds made by birds are classified as songs and call-notes depending on the length and function. According to W.H.Thorpe (1956), "a bird's call-note, in contrast to its song, is a brief sound with a relatively simple acoustic structure."

Call-notes indicate alarm, anxiety, warning, intimidation and greeting. For instance, the quail uses a special note as a gathering call when the members of the covey are scattered. Similarly, the young of birds make distinctive food calls when hungry and quite different

calls when adequately fed.

Many definitions of bird songs have been given, but recent knowledge of bird behaviour proves that these definitions are either too restrictive or too broad. The bird song has been defined by Saunders (1929) as "a vocal performance usually confined to the male and to a definite season of the year; that season includes the time of courtship and mating". A song is not necessarily musical nor is it always confined to the male. For example, when the common pigeon (*Columba leavia*) dances in front of its 'sweet heart' and utters very unmusical "gootre-goo, gootre-goo", the call may be defined as a song because the behaviour shows that the male is trying to entice the female. It has been repeatedly proved that most, if not all, birds sing to attract the opposite sex, or to defend their territory. That is why songs reach their highest intensity during the breeding season.

Bird songs serve many functions and express a variety of emotions. They are classified as territorial or advertising songs, signal songs and emotional songs. The territorial song is related to territoriality in birds, and according to Josselyn

Van Tyne (1959), "it is one of the biological isolating mechanisms that guarantees the mating of individuals belonging to the same species."

In almost all cases it is the male who sings territorial songs. The sound signifies he has a territory and that other males of the same species should not trespass his 'home'. Other equally important role of this song is to attract the mate. For example, in the snow bunting (*Plectrophenax nivalis*), Tinbergen (1938) noted that the mated male abruptly stops singing, but any threat to the male's territory, or the loss of the mate, causes him to renew singing. Many birds such as robin, bulbul, sparrow, weaver bird, etc., which raise two or three broods every year, intensify their singing before every mating. That is why we hear songs throughout the breeding season. While one bulbul may be silent feeding the young, another may be singing and attracting his mate for the beginning of second or third brood.

The function of the second category—the signal song—is to coordinate the activities of birds, particularly the mated pair. In some birds the signal song may be same as the territorial song, only the function differs. In such cases, the signal songs may be an integral part of courtship behaviour.

Duet or antiphonal singing of birds is unique in the animal kingdom. In many species of birds found in dense tropical forests, the notes of the male and female, which are at some distance apart, are different. The two sexes sing antiphonally. This is the way of informing a bird the whereabouts of its mate.

In antiphonal singing, one mate sings a few notes to be taken up by the other. For example, in the magpie lark of Australia, one bird calls "te-he" and the other quickly replies "pee-o-wit". Some birds



Some common birds known for their melodius songs or mimicry of others. (clockwise from left) Indian Parakeet, Rufousbacked Shrike, Shama, Mocking Bird, Blackbird, Hawk Cuckoo, Hill Mynah, Malabar whistling Thrush

synchronize so perfectly that unless both partners are in view, it is impossible to know that more than one is singing.

The songs which are neither territorial nor signal are classified as emotional types. The idea that birds sing for the fun of it is perhaps not entirely baseless. Everybody knows that young energetic boys and girls frequently burst into song when they are happy. Similarly, in birds emotional singing is a normal outlet of excess energy. In listening to the melodious song of *shama* (*Copsychus malabaricus*), one gets the impression that the bird is enjoying itself.

Mimicry

Another unique vocal development in birds is mimicry. Some birds such as the shrikes (*Laniidae*), bower-bird (*Ptilonorhynchidae*), mocking bird (*Mimidae*), parrots (*Psittacidae*) and hill myna (*Gracula religiosa*) not only sing songs of their own species but perfectly imitate notes and songs of other species. The most skilled and persistent mimics are the bower-birds of Australia. The spotted bower-bird is credited with mimicking the sound of thunder, barking of dogs, the noise of cattle moving through bush, the croaking of frogs, honking of cars and weeping of a child! There are few sounds they cannot produce. In our country the Rufous-backed shrike (*Lanius schach*), is supposed to be the best mimic. According to Dr. Salim Ali (1961), "it is a very accomplished mimic, quick at learning and with a retentive memory. Harsh squeals of a frog caught by snake, yelps of newly born puppy, tame grey partridge's call prefaced by its human owner's whistles, and calls of numerous birds even long after many have migrated, are imitated to perfection". So next time if you hear the plaintive metallic "Piu-piu-pee-

pee-piu...pee-piu-piu" of the pied crested cuckoo (*Clamator jacobinus*) at a time when the cuckoos have long since left off calling or have migrated, look for this shrike.

In all languages, the popular names of some birds are based on the onomatopoeic words from their calls. For instance, the call of the Hoopoe (*Upupa epops*), is a loud "hoo-poo" or "hud-hud", repeated two or three times, which has given rise to the names current in various languages—all onomatopoeic in origin. No doubt the above mentioned bird is called *Hudhud* in Hindi and it is known as Hoopoe in English.

The call of a bird is interpreted differently in different languages. A common cockerel may seem to say "cock-a-doodle-do" to an Englishman, but a German thinks it says "kikerike" and a Japanese hears it as "kookke-kokke". Each can hear only the phonetic sound of his own language. Another example is of the call of the common hawk-cuckoo or brain-fever bird (*Caculus varius*). The loud screaming song of this bird sounds as "brain-fever" to an Englishman, while a Hindi speaking person may hear it as "pee-kahan?" (Where is my love?). A Marathi may interpret it as "paos-ala" (Rain is coming).

The call-note of the once widespread black partridge (*Francolinus francolinus*) is a loud and grating cry of several syllables. The high pitched "chick-cheek-cheek-keray" is rendered by the devoted Muslims as "Subhan-teri-qudrat" (O Omnipotent, thy power). The sport-loving people take it as "noon-piyaz-adrak" and infer from it that the bird should be prepared with salt, onion and ginger.

Legends of bird songs

Many legends have originated from the songs of birds. It is popularly believed in the peasant community

that the pea-fowl (*Pavo cristatus*), our national bird, heralds the coming of rains by its loud trumpet-like scream "minh-ao" (Come rain). The peacock is very noisy during the monsoon months, especially on cloudy days. Topoor farmer for whom untimely rain may make a difference between starvation and plenty, the call of the peacock represents his inner prayer to the rain-god. The peacock was thus venerated and protected even before it was declared a national bird.

The tales of unfulfilled love and grief-stricken lovers arouse interest in all societies. Our folklore is also full of such stories and many legends are based on bird calls. For example, the Great Himalayan barbet (*Megalaima virens*) utters monotonous, mournful cry, "pee-oh", "mee-oh". The bird sits high up in some shady tree and owing to the green colour of its plumage and ventriloquist song becomes difficult to locate. The inhabitants say that the bird is the reincarnation of the soul of a suitor who died in grief at the unjust termination of his love. He is therefore proclaiming to the world "un-nee-ow, un-nee-ow"—injustice, injustice.

The beautiful surkhab (*Todorna ferruginea*), famous for its feathers, has an unhappy story woven around its voice, (Whistler, 1935). In vernacular language the surkhab or the Brahminy duck is called *Chakwa-Chakwi*. It breeds in Ladakh and Tibet, but during winter migrates to plains and it is generally found on the sand-banks of rivers. They live in pairs or small parties. At night they feed on vegetable matter, molluscs, aquatic insects, fishes and reptiles. While engrossed in feeding the pair often gets separated and calls each other. This has given rise to the legend that the surkhab have the souls of erring lovers, who were doomed to remain within sight and hearing but separated by the flowing stream. The nasal

conversational call "aang-aang" of the pair is rendered to form the names of *Chakwa* and *Chakwi*. The Chakwi asks "Chakwa-a-unga" (Chakwa, I will come). The Chakwa sadly replies "Chakwi-na-ao" (Chakwi, do not come).

According to Dr. Salim Ali (1961) the most accomplished songster of our country is the greywinged black-bird (*Turdus boulboul*) of the Himalayas; the Malabar whistling thrush (*Myiophonus horsfieldii*) and the the Shama (*Copsychus malabaricus*) come next in order.

The Malabar whistling thrush is very restless, always flitting through the trees or feeding on an open hill stream. During breeding season, which is from February to August, the male sings a musical whistling song. The bird is partial to well-wooded hill streams of the Western Ghats, Madhya Pradesh and Orissa. As it sings aimlessly up and down the

scale, it is known as the "Whistling-schoolboy" in the Nilgiris.

Bird-watching is a fascinating hobby. It becomes more interesting when we start interpreting the songs--scientifically or mythologically. The villagers sometimes tell amusing tales concerning the call of birds. While I was bird-watching in Kukrail near Lucknow, a villager told me that the Dumri or the Common Babbler (*Turdoides caudatus*), which lives in flocks of a dozen birds, is altruistic in its behaviour. Every bird constantly advises the other "Tohee-pee-o, tohee-khayoo" (You drink, you eat).

There are thousands of legends related to birds song. If, instead of killing them, people start observing and recording bird-life, our literature will be greatly enriched.

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A.M.U.

Aligarh-202001

sound. The stethoscope then amplifies and concentrates the sound in one direction by the method of 'multiple reflection' inside its hollow tubes and finally conveys it to the ear so that it can be heard distinctly.

The modern stethoscope consists of a small metallic funnel or a hollow drum *M* which collects sound waves (Fig. 1). It is further connected to a small rubber tubing *R* which is attached to one end of a three-way metal tube *T*. To the other two ends of the *T*-tube are attached two ear phones *E*₁ and *E*₂ connected by rubber tubes *R*₁ and *R*₂. The doctor listens through these ear pieces when the funnel-shaped piece of metal *M* is placed on the surface of the body organ. The funnel carries a metallic disc *C*, which has a very sensitive diaphragm *D* encased in it. The density of material of the diaphragm is kept nearly the same as that of human skin so as to ensure maximum transference of the sound energy from the body organ under test to the diaphragm. *S* is the spring which helps the doctor in adjusting the distance between the ear-phones *E*₁ and *E*₂ thereby making the whole instrument quite flexible and convenient.

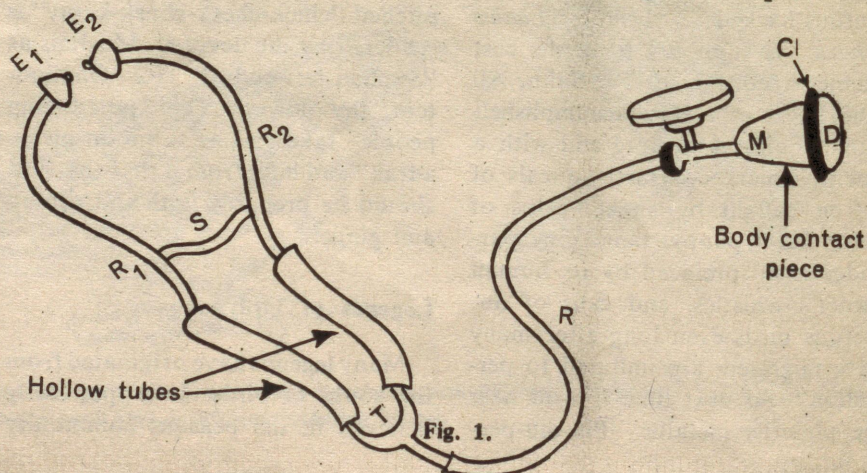
The metallic case *M* containing the sensitive diaphragm *D* is gently pressed against the body organ (e.g., heart, lungs, etc.) to be checked. The sound waves and the vibrations due to beating of this part of the

How a stethoscope works

HAVE you ever wondered what the doctor hears when he conducts a physical examination of a person with a medical instrument called stethoscope? The stethoscope has derived its name from two Greek words meaning "chest observer", because it was first used in detecting some chest disorders. René Laënnec (1781-1826), a French physician, is credited with inventing the stethoscope in 1816.

Heart is a muscle which expands and contracts regularly, pumping the blood around the body. It occasionally produces a sound beat or vibration that may sound 'lub-dub-shish' or 'lub-shish-dub' which travels through bones, muscles and other tissues of the body. This low pitched sound produced in lungs or beating heart is too faint and is beyond the hearing capacity of a

person. The stethoscope is a simple device for picking up sounds and vibrations (e.g., heart-beat, pulse-beat, etc.) made by various organs of the human body. The sound waves enter the hollow tube in which they are successively reflected from its side walls. This phenomenon is known as 'multiple reflection' of



body are communicated to the diaphragm *D* which starts vibrating in resonance with a frequency equal to that of the original vibrations of the body organ. These vibrations are collected by the wide end of the funnel and enter the hollow tubes R, T, R₁ and R₂ in which they are successively reflected internally from side to side. These tubes lead the vibrations to ear sthrough earpieces E₁ and E₂. In this way, the sound energy is concentrated in a much smaller space. As a result, the sound intensity reaching the ears is increased considerably. The original faint sound from the heart-beat or pulse-beat, which is exactly reproduced in the ear phones, can be amplified and heard distinctly.

Lungs lie in a cavity surrounded by ribs and the diaphragm. When a person breathes in, the diaphragm is lowered and the rib-cage expands so that some extra space is created. Air then flows into lungs to fill in the extra space. It has been observed that a number of chest diseases cause accumulation of a sticky fluid or mucus in lungs or in their surrounding cavity. When lungs are free from infections, tapping a healthy chest with flexed fingers or thumping the back produces a clear hollow sound. If they are infected, they become partly filled with mucus fluid and give out a dull, solid thud.

With the use of stethoscope doctors can make accurate diagnosis of chest diseases and follow fairly well the spread of the diseases in the body. It is also possible to detect presence of foetus in a pregnant woman, because the heart of the foetus beats almost twice as rapidly as that of an adult woman. This is, however, not the complete list of its medical applications.

Finger multiplication

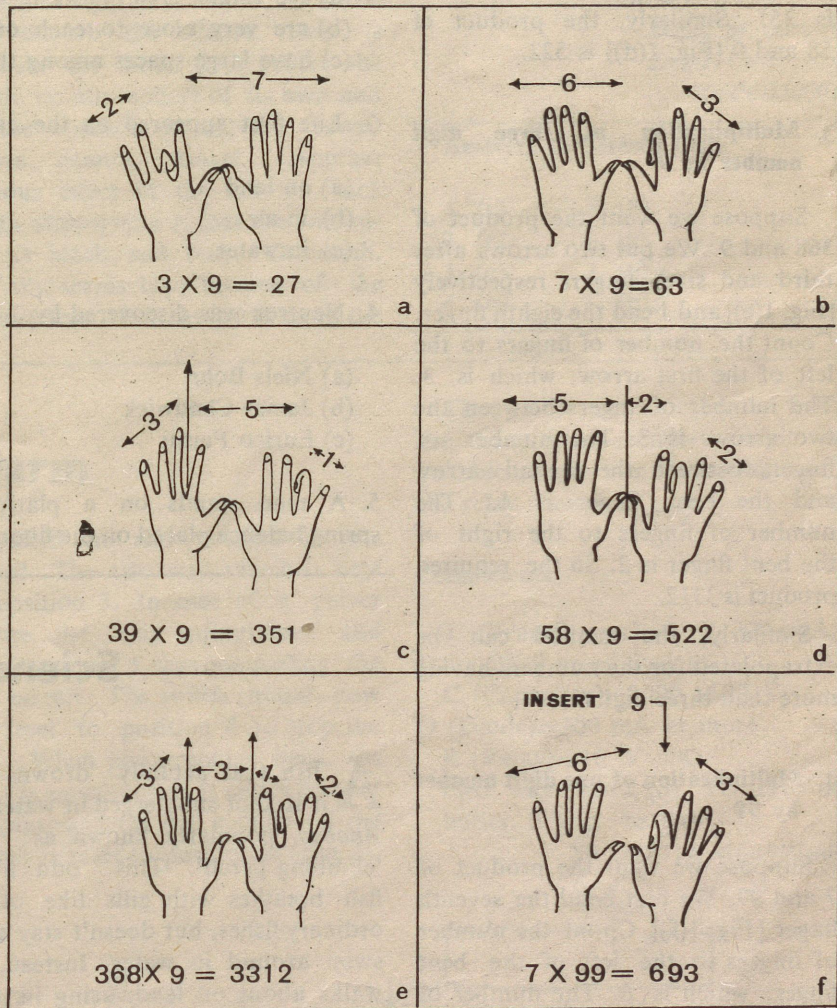
IN the *S.R.* (April 1977), some methods of multiplication were discussed. An interesting method of multiplication known as finger multiplication is given below. The method is useful only to multiply a given number with 9. The digits of the number which is to be multiplied must be in increasing order.

For example, in the number 246, the digits 2,4, and 6 are in increasing order. So the multiplication 246×9

is possible by this method. In the number 143 the digits 1, 4 and 3 are not in increasing order. So the multiplication 143×9 is not possible by this method.

1. Multiplication of one digit number by 9.

Suppose we want the product of 3 and 9. We bend in the third finger [Fig. 1 (a)]. Count the number of



B. K. SHARMA

Fig. 1.

fingers to the left of the bent finger, which is 2. The number of fingers to the right of the bent finger is 7. So the required product of 3 and 9 is 27. Similarly, the product of 7 and 9 [Fig. 1(b)] is 63.

2. Multiplication of two digit number by 9

Suppose we want the product of 39 and 9. We put an arrow after third finger (Fig. 1(c) and bend the ninth finger. Count the number of fingers to the left of the arrow which is 3. The number of fingers between the arrow and the bent finger is 5. The number of fingers to the right of the bent finger is one. So the required product of 39 and 9 is 351. Similarly, the product of 58 and 9 [Fig. 1(d)] is 522.

3. Multiplication of three digit number by 9

Suppose we want the product of 368 and 9. We put two arrows after third and sixth fingers respectively [Fig. 1(e)] and bend the eighth finger. Count the number of fingers to the left of the first arrow, which is 3. The number of fingers between the two arrows is 3. The number of fingers between the second arrow and the bent finger is 1. The number of fingers to the right of the bent finger is 2. So the required product is 3312.

Similarly, the method can be extrapolated for the numbers having more than three digits.

4. Multiplication of one digit number by 99

Suppose we want the product of 7 and 99. We first bend the seventh finger [Fig. 1(f)]. Count the number of fingers to the left of the bent finger, which is 6. The number of fingers to the right of the bent finger is 3. Between these two numbers, 6

and 3, insert 9. So the required result is 693.

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Science Quiz

1. The refractive index of the glass used in an x-ray tube is

- (a) more than 1.5
- (b) equal to 1
- (c) less than 1

2. A substance in the gaseous state can be easily compressed because the molecules in this state

- (a) are small
- (b) are very close to each other
- (c) have large spaces among them

3. Life first appeared on the earth

- (a) on land
- (b) in air
- (c) in water

4. Neutron was discovered by

- (a) Niels Bohr
- (b) James Chadwick
- (c) Enrico Fermi

5. A man stands on a platform spring balance placed on the floor of

a lift. When the lift is stationary, his weight is indicated by the balance as W kg. If the lift suddenly starts moving down, the weight shown will be.

- (a) W kg
- (b) less than W kg
- (c) more than W kg

6. Dynamo is a device which

- (a) converts electrical energy into mechanical energy
- (b) produces an explosive (dynamite)
- (c) converts mechanical energy into electrical energy

7. Oxidation process involves

- (a) increase in negative valence
- (b) loss of electrons
- (c) gain of protons

8. Which of the following planet is nearest to the sun?

- (a) Earth
- (b) Mercury
- (c) Venus

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Science oddities

A fish that actually drowns if it is kept submerged in water is *Anabas*, popularly known as the 'climbing perch'. This odd little fish breathes with gills like other ordinary fishes, but doesn't stay and swim around in water. Instead, it walks about on land, using its tail and fins to propel itself, and is even said to climb trees in search

of insects to eat. It is able to behave in this un-fishlike manner because it has special accessory breathing organs situated in a chamber above the gills. These rosette-shaped structures serve as air reservoirs, somewhat like lungs, enabling the fish to breathe atmospheric air like land animals.

'SILENT SOUND' may appear to be a contradiction in terms, for by definition, sound is something we can hear. But 'silent sound' does exist—it is merely sound that is 'silent' or inaudible to human beings. It has been estimated that the average human ear can hear sounds with a frequency of about 15,000 vibrations per second. Keen ears can detect sounds of upto 20,000 vibrations per second. If the sound is more high pitched than this, we can no longer hear it. However, many animals like bats and dogs are able to hear these 'ultrasonic' sounds. Bats actually use these high frequency sounds to find their way in pitch darkness without bumping into obstacles.

WOOD is usually light enough to float in water, but not the wood of the ironwood tree. A characteristic tree of the Bornean swamp forest, the ironwood is aptly called *Metrosideros* (from 'metra', heart of a tree and 'sideron', iron), for its wood is so hard and

dense that it will actually sink in water! The wood is very much in demand for making anchors, rudders, beams, etc., for not only is it strong enough to last well over a century without decay, but it even seems to be insect proof. The Japanese are said to have regarded it so valuable that only royalty was allowed the use of the wood.

FOR those who cannot concentrate on their work in noisy surroundings, the moon would be the ideal place to go for the study holidays. On the surface of the moon it is absolutely quiet, and even if someone were to bang a set of drums right next to you, it would not disturb the silence. This is because the moon has, unlike the earth, no atmosphere of its own and in the absence of air, the sound waves cannot travel. Another curious effect of the moon's lack of an atmosphere is that the moon-sky is black, not blue. On earth, the sky seems blue because of the atmosphere. It is the particles in the

air that scatter the short light waves at the blue-violet end of the spectrum and make the sky appear blue.

THE chromosomes in the cells of every organism carry the hereditary information from one generation to the next. The number of these chromosomes vary greatly from species to species. *Aulacantha*, a tiny radiolarian, has sixteen hundred chromosomes! Why a simple, one-celled creature requires so many chromosomes, while the most complex and highly evolved animal, namely, man has only forty six, is a mystery.

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Answers to Science Quiz

- | | |
|--------|--------|
| 1. (c) | 5. (b) |
| 2. (c) | 6. (c) |
| 3. (c) | 7. (b) |
| 4. (b) | 8. (b) |

Do it at home

Power alarm

MANY electric appliances, like refrigerator, need to be switched off in case of a power failure and switched on again when the power supply is resumed. During the day when the power goes off it is difficult to know when it had. The simple and inexpensive gadget described below will give a signal when there is a power failure and again when power is resumed.

The main circuit consists of a relay and a two-way switch with a bell and batteries. The relay has two sets of contacts, one which is closed when the relay is magnetised, and another when it is off.

The working is simple enough. When the power is "on" the relay

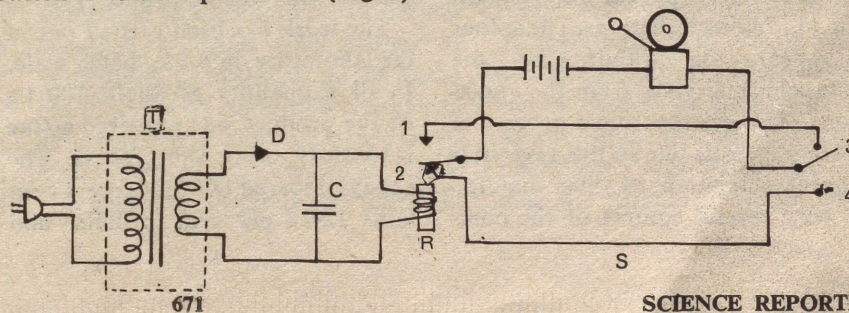
is pulled in and contact 2 gets closed. The two way switch is kept in position 3. In case of a power failure the relay springs back and closes contact 1 thus completing the bell circuit. The switch should now be reset to position 4 to stop the bell. When power comes back, the relay is again pulled. It closes contact 2 again and the bell sounds till the switch is reset to position 3. (Fig. 1).

The power for the relay is from the transformer-rectifier circuit. A suitable transformer compatible with the relay should be used.

Components

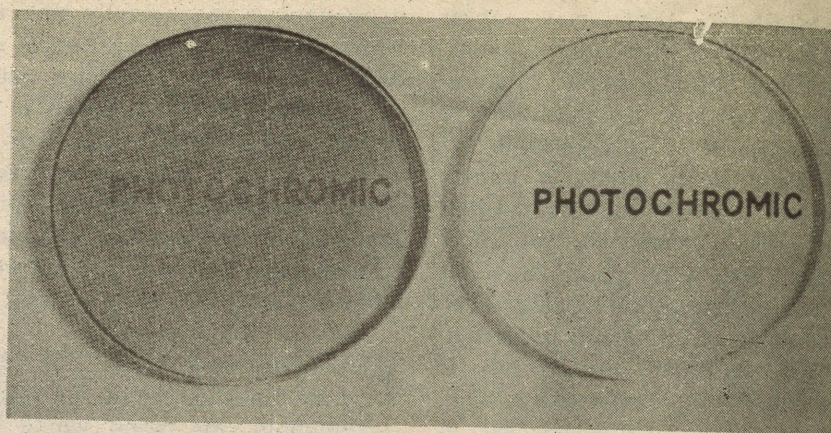
- T (Transformer)=9 V 200 mA,
Delta BE 9 or equivalent
C (Capacitor)=1000 μ f 12 V
D (Diode)=300 mA or more
R (Relay)=10 V 50 Ω
Two way switch (S), 9V bell or
butter, 9 Volt battery

SHILADITYA MAZUMDAR



SCIENCE REPORTER

Science in Industry



CGCRI develops photochromic glass

THE Central Glass & Ceramic Research Institute (CGCRI), Calcutta, has developed a process for the production of photochromic glass. Photochromic glasses are used as lenses for prescription spectacles and sunglasses for protection against glare. They are also used in window panes, windshields of cars and in other areas where dynamic control of sunlight as a function of its intensity is needed. Photochromic glasses also have applications in optoelectronic storage devices with self-erasing of information, and as modulators in optical transmitting systems where changes in the quantity of light may be used for control of regulatory purposes. At present, photochromic glass is entirely imported.

Photochromic glasses get deeply coloured on exposure to sunlight and ultraviolet radiations. The colour disappears on withdrawing the photochromic glass from the radiations. The photochromic process in these glasses is due to the reversible photodissociation of silver halides. A very careful control of the com-

position, batch preparation, melting schedules, annealing and heat treat-

ment is required to make the glass photochromic.

Protein chewy candy

PROTEIN chewy candy is a new product not available in the market at present. However, it may be liked by persons of all age groups as it is a new, tasty and nutritious confectionery. As such, a good demand for the product could be expected. The price envisaged for this product in the market is about Rs. 17/kg.

According to the process developed by the Central Food Technological Research Institute, Mysore, the necessary ingredients for chewy candy are taken and mixed with a thick sugar syrup and cooked in a steam-jacketed kettle with stirrer. The cooked mass is subjected to the usual operations like plating, rolling, cutting, wrapping and final packing. Many of the candy flavours available in the market have been found to be compatible with this confectionery.

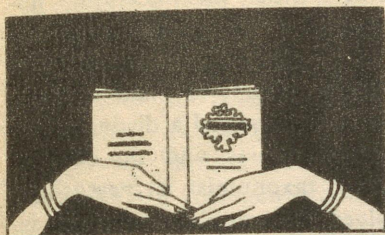
The work has been carried out in the laboratory on 1.5 kg batch scale. In all, a quantity of about 100 kg of the product was prepared at the laboratory using this process. The candy prepared by this process contains 12-16 per cent protein and

therefore could be used as nutritional supplement by children and persons of all age groups. The conventional candy manufacturers can use their existing facilities to produce this candy. This process has also been tried on 100 kg batches in a conventional commercial confectionary factory. The consumer acceptability of the product has been established with persons of all age groups, especially children.

The raw materials required are edible-quality solvent-extracted groundnut flour or protein isolate, sugar, liquid glucose, condensed milk vanaspati, suitable flavours and permitted food colours. All the raw materials are available indigenously.

The capacity of the suggested economic unit is 570 kg of chewy candy per 8-hr shift. The land required for plant and building is 500 sq. m while that for storage is 300 sq. m.

The investment on plant and machinery and the working capital would be Rs. 1.80 lakh and Rs. 4.25 lakh respectively. The estimated cost of production is Rs. 11.40/kg of chewy candy.



BOOK REVIEWS

HANDBOOK OF FOOD AND NUTRITION by M. Swaminathan, *Ganesh & Company*, 71, Pondy Bazaar, Madras-17, Pp. 288, Rs. 12.00.

NUTRITION has been a neglected subject in India, though in this ill-nourished country information on nutrition should be available to all in the simplest form possible. Partly the cause of the dearth of information on this important subject in India is that few books have been written on it and fewer relevant researches have been done in our universities and institutes on what is good food for Indians of different ages, regions and occupations. Of late, some institutes have done some work on nutritional problems in India, but their researches touch only a fringe of the vast field.

One such attempt is the book written by M. Swaminathan, an expert on nutrition. The book has been written in a simple language and is moderately priced (Rs. 12 per copy) and covers a wide range of subjects under nutrition. The book will be useful to housewives, nutritional experts and students of home science, etc.

A common shortcoming in the treatment of this subject is that the nutrition values of different foods and feeds are invariably quoted from western sources which are valid for the foods available there. It is forgotten that the same food may have different values in different regions of the earth. For instance, milk, eggs

or tomato available in US vary in nutrition values from those available in India. Therefore, quoting the nutritive values of the foods of western countries may be misleading in the Indian context. It is time that our experts do research for determining the nutrition values of foods available in India. Such a research effort will give a correct picture of the quality of food that we take and also will be a better guide to what we should eat and in what quantity. Our dependence on foreign data for nutrition values of foods should now be given up.

The author has recommended some ideal diets for various age groups and for men and women in different occupations. Here, the information has been given in a scientific language which will not make sense to lay readers. For instance, when you say that a pregnant woman needs more calories and proteins, she will be at her wit's end to know precisely how much more milk or how many more eggs she should add to her normal diet. Instead of describing ideal foods in terms of calories and proteins, the author should have given this information in terms of weights so that the information makes immediate sense to lay readers.

DESIGN=OUT=MAINTENANCE AND INSTRUMENT AIDS by Durgesh Chandra, *Universal Book Corporation and Instrument Association of India*, Ahura Printing Press, Bombay, Pp. 281.

WHILE India has built a large industrial enterprise its productivity is dismally low. A Japanese steel worker produces 200 tonnes a year compared to 60 tonnes by an Indian. America produces 1400 tonnes of cement per man-year while the figure for India is 190. America's aluminium productivity is 200 tonnes per man-year as against 25 tonnes in India. The figure for sugar is 450 tonnes in

the USA and a meagre 24 tonnes for India.

Why is Indian productivity so low? Can it be improved? This is the subject matter of the timely book by Mr Durgesh Chandra, an experienced plant engineer. This comprehensive volume describes several ways to maximise production, reduce waste, and increase safety and efficiency of plants.

Productivity is the ratio of output of goods and services to the input of resources like materials, money, machinery and manpower—or what Mr. Chandra calls 4M's. He argues that this ratio can be improved by Design-out-Maintenance or DOM. It is a technique which, in simple terms, means that the health of the machines, like that of a human body, must be measured while they are working and not after they break down. DOM also means that logical questions must be asked and answers found whenever a machine develops defect: What is the cause of the defect? Can the defect be eliminated? Is there a way to detect the defect when the machine is working? Can the machine be eliminated from the plant? If so, what is the alternative way of performing the function which the defective machine is assigned to do?

The book is full of case studies pertaining to a rayon plant and examples of specific applications of DOM technique.

The book gives a long list of instrument aids to monitor the machine's health while working. The techniques are described in detail particularly in regard to vibration analysis, ultrasonic flaw detection, radiography and dye penetrants. Noise and vibration analysis, according to the author, is one of the most important aspects of maintenance in the industrially advanced countries. Ultrasonic gauge can be used to measure thickness of metals and articles like aircraft propellers, large flat sheets of steel and aluminium, castings, seamless

tubes, ship plates and storage tanks as accurately as a micrometer.

The author describes the application of pert chart and queueing theory in maintenance and has developed certain "indices" for evaluating maintenance work. Maintenance is an integrated system which derives sustenance from other branches such as financial management, personnel management, materials management and network analysis. Mr. Chandra has nicely knitted together these various aspects and brought out their interrelationships under one roof which covers budgeting, organising, on-stream test, flaw detection, non-destructive testing, safety aspects, tribology and materials management.

The book may be of great help to maintenance engineers, project managers, industrial executives and manufacturers of instruments and consulting engineers engaged in the design and supply of instruments and control systems for non-destructive testing.

K. S. JAYARAMAN

INDIAN SCIENCE INDEX 1975

Edited by Satya Prakash and Compiled by Syed Mohammed Ali and Har Saran Sharma, *Indian Documentation Service*, Gurgaon/New Delhi, 2, Ansari Road, Panna Bhawan, Daryaganj, New Delhi-110002, Pp. 140, Rs. 50.00.

OFTEN, Indian scientific and technical journals are underestimated. Even an Indian research worker wishes to publish his work in a reputed foreign journal than in an Indian journal. Our elderly scientists also give more weightage to a paper published in a foreign journal. As a result, most of the research work done in our country is published abroad. The amount of literature published in Indian journals is a small percentage of the total literature published by Indians. So, a bibliographical organisation, attempt-

ing to cover every expression of Indian thought, would have to seek help more often of foreign journals rather than Indian ones. Confining to Indian journals would mean a highly incomplete study of Indian thought in a particular discipline. Therefore, such a bibliographical record has a limited utility for a researcher.

The above fact, however, in no way lowers the value of the maiden attempt made by *Indian Documentation Service* to produce this bibliography of Indian scientific and technical literature. It is a beginning in a direction in which we have a long way to go. This index is the first of its kind, and is the first annual volume of Indian Science Index. It is a subject index to articles, research papers, research notes, conference/seminar/symposia proceedings, transactions of societies, significant editorials, scientific news and book reviews from selected Indian journals in all disciplines of science, technology and medicine. The present volume lists over six thousand articles derived from 150 journals published during 1975. It lists the titles of the publications alphabetically on the dictionary pattern. But many important journals and periodicals have been left out. It is hoped that in the future issues of this science index more journals and periodicals would be added. It would be excellent if a cumulative bibliography of last ten years of Indian technical literature is published, along with the abstracts, more particularly of conference/seminar proceedings.

RAVINDRA N. GOËL

AN INTRODUCTION TO THE TAXONOMY OF ANGIOSPERMS

by Y. D. Tiagi and Shashikala Kshetrapal, *Ramesh book Depot*, Jaipur, Pp. 444, Rs. 24

PLANT Taxonomy constitutes a vibrant aspect of botany

dealing with identification, nomenclature and classification of plants. Although representing the most ancient of plant sciences, it has now acquired a distinct interdisciplinary bias and the contemporary taxonomist is increasingly involved in grappling with the intrinsic principles underlying the evolution and relationships among plants. The rapid strides taken in this direction have left a void in our curriculum and texts, and there is indeed an urgent need for a book which would reflect kinesis of this discipline. The present volume, although an improvement over the existing Indian books on the subject, fails to live up to this modest demand.

After a brief introduction, which, curiously, deals with some rather intricate problems of delimitation and interrelationships of major groups of flowering plants, a few pages are devoted to the meaning and scope of plant taxonomy. This treatment is orthodox and insufficient and the archaic overpowering influence of floristics envelopes the succeeding pages. The concepts of taxonomic categories are shorn of current ideas and thinking. For example, the biological species concept is barely mentioned, and only some stray infraspecific categories are defined. The chapter on plant nomenclature might prove useful because of the simplicity of presentation. The details of Indian herbaria and botanic gardens, too, are welcome, but the information appears to be factually incorrect at several places. It might seem gratifying to learn that the herbarium of Forest Research Institute, Dehra Dun, houses 35 lakh plant specimens, and is larger than the herbaria at Cambridge, Paris, Vienna, and Zurich, but a lot of facts are needlessly sacrificed in the process of catering to such patriotic sentiments. Some high-placed Indian botanists have likewise been erroneously accredited with outstanding contributions to herbaria gardens

and to several other fields of taxonomic activity.

The major part of the book is devoted to descriptions of some selected (according to university syllabi) families of angiosperms which are arranged according to an obsolete system of classification. The last chapter, which deals with the interesting problem of phylogeny of angiosperms, could have been more useful if the relevant works of modern investigators such as Behnke, Walker, Lundquist, Axelrod and Favre-Duchartre were also taken into account.

Among the serious drawbacks of the volume are its total apathy toward modern aspects of taxonomy and the glaring ignorance of recent developments in the field. The erudite reader would also be embarrassed to find that a sizeable part of the information taken from other books is not appropriately acknowledged. The line-drawings are tolerable but the text is replete with errors. If one feels that even impure water is good for the thirsty, the book may be recommended to students. This is because there is hardly any other book available in Indian market which offer even a semblance of justice to this important branch of botany.

A. K. BHATNAGAR

LABORATORY MANUAL OF INORGANIC CHEMISTRY by H.M. Chawla, A.C. Handa, R.C. Rastogi, *Sultan Chand and Sons*, 4792/23, Daryaganj, New Delhi-110002, Pp. 185, Rs. 5.00.

THIS book has been written for B.Sc. General and Honours students of Indian Universities. It covers various methods of inorganic analysis. Essentially, the book has not succeeded in its aim as formula-

ted in preface, i.e., to fill the gap between the theory and the experiment. Authors have made no effort in this direction. It seems they preferred to give various schemes of analysis as a mere story without discussing the principles involved. At the same time, authors have made no attempt to familiarize students with various laboratory techniques. Practically no illustrations have been given which are rather necessary for undergraduate students in understanding the subject.

First few chapters of the book deal with the methods of qualitative analysis which includes semi-micro-qualitative analysis and also chromatographic methods of separation of some radicals. Authors have discussed the precipitants other than H_2S , such as thioacetamide and potassium trithiocarbonate. Further chapters discuss quantitative methods of analysis. Various volumetric methods such as acidimetry and alkalimetry, redox titrations, iodometry, precipitation titrations and complexometric titrations, etc., have been discussed. Another chapter deals with various gravimetric methods of analysis. One chapter has been devoted to inorganic preparations. As usual, several appendices have been given at the end of the book.

ASHOK KUMAR GUPTA

ELECTRICITY AND MAGNETISM by D. L. Sehgal, K.L. Chopra, and N. K. Sehgal, *Sultan Chand and Sons*, (as above) Pp. 757. Rs. 20.

THIS is yet another volume which is an addition to the family of books on electricity and magnetism. It has no outstanding feature that needs special mention. Rather, it has been written with a view to present only one volume on the subject.

It includes subject matter needful for students appearing in graduate or competitive examinations.

The book, as per the convention, is divided into three parts: (a) Electrostatics, (b) Magnetostatics, and (c) Current electricity. All these parts have been described in the usual fashion but more elaborately. More than half of the text is devoted to current electricity. This part is exhaustive and the chapters on electromagnetic induction and magnetic properties of materials are interesting. The parts on electrostatics and magnetostatics have been described in an easily understandable language. They cover basics like principles, fields and potentials. Dielectrics and terrestrial magnetism have been well presented.

The book is in M.K.S. system of units. However, at places the formulae in C.G.S. system have also been given. The compilation of electrical units in one chapter needs appreciation. The text is well illustrated and explained, but sometimes the language seems borrowed. As the standard texts mention vector analysis to discuss various principles of electricity and magnetism, the authors have devoted one chapter on vector analysis.

An interesting feature of the book is that each chapter has been summarized at the end, where a special care is given to unit systems. Many solved and unsolved examples have been included in all the chapters, which end with a series of questions. This scheme of presentation has raised the quality of the book. Sometimes the subject matter is so technical that it is difficult for a general student to understand it.

The book will be of use to B.Sc. (Pass and Honours) students.

VIJENDER SHARMA

SPICES AND CONDIMENTS by J. S. Pruthi, *National Book Trust*, A-5 Green Park, New Delhi-110016, 1976, Pp. 270, Rs. 14.50.

THIS semi-technical book on spices and condiments, though it lacks agricultural, technological and marketing aspects, is still a storehouse of information for a technical person as well as for a layman. The above mentioned missing information, however, can be obtained from other sources.

The book is written in a lucid language and presents to the reader the scientific and vernacular names of spices, their synonyms, and geographical distribution, morphological description, physical and chemical properties of about seventy spices. Some of the spices not used in India but described in this book enhance our knowledge of spices used elsewhere. Two annexures showing export, area and production of some spices though outdated still give an idea of the potential that India possesses in these fields. Some typographical errors have persisted even though an errata has been included at the end of the book. The limited number of plates though informative are badly printed.

Those who deal in 'desi' medicine will find some useful information in this book and it will also help the layman in finding the uses of many of the spices in household remedies. The cost of the book, is, however, high as compared to other National Book Trust publications.

M. ILYAS

PROBLEMS IN PHYSICS by B. L. Dhar, K. L. Chopra, N. K. Sehgal, and D. L. Sehgal, *Sultan Chand and Sons*, 4792/23, Daryaganj, New Delhi-110002, Rs. 20.00

THE present physics syllabi of our universities hardly lay any emphasis on solving problems and most of our examinations consist in mugging up the text-book material and then reproducing it in the examination hall. This state of affair is deplorable, particularly when in a subject like physics understanding of concepts and techniques is crucially dependent on problem solving. This problem is further aggravated by non-availability of good books on the techniques of problem solving.

The book under review, as claimed by authors, is written to fill this gap. The book is confined to the B.Sc. syllabus of Indian universities. It is divided into two volumes, first dealing with mechanics, heat, and optics; the second volume dealing with sound, electromagnetism, and modern physics. In each chapter of the book, the authors just give solved examples. This makes the title of the book inappropriate; it would have been better if the title were 'Solved Examples in Physics.' The book would have been certainly more useful if the authors had given only hints to solve the problems. A list of important formulae before the beginning of each chapter is the only redeeming feature of the book.

MANMOHAN GUPTA

Books Received

1. **EARTH, THE LIVING PLANET** by Michael J. Bradshaw, *Hodder and Stoughton*; Available at B. I. Publications, 359, D. N. Road, Bombay, 400023, Pp. 302, Rs. 79.20 (£ 4.95)
2. **INVERTEBRATES** by R. L. Kotpal, S. K. Agarwal, R. P. Khetarpal, *Rastogi Publications*, Shivaji Road, Meerut-250002, Pp. 660, Rs. 17.50
3. **RECENT ADVANCES IN MINING AND PROCESSING OF LOW-GRADE AND SUBMARGINAL MINERAL DEPOSITS** by Centre for Natural Resources, Energy and Transport, *Pergamon Press*, Headington Hill Hall, Oxford OX3 OBW, England, Pp. 192, \$ 25.00
4. **ADVANCED SECOND YEAR T.D.C. PRACTICAL PHYSICS** by S.L. Kakani, H.B. Saxena, and M.S. Lodha, *The Student's Book Co.*, Chaura Rasta, Jaipur-302003, Pp. 184, Rs. 7.50
5. **FIRST YEAR T.D.C. NUMERICAL PHYSICS**, Kakani, Saxena and Mathur, *The Student's Book Co.*, (Same as above) Pp. 311, Rs. 12.75
6. **FIRST YEAR T.D.C. PHYSICS** by Kakani, Saxena, Jain, Khamesra, Sokhi, *The Student's Book Co.*, (Same as above) Pp. 615+supplement, Rs. 22.75

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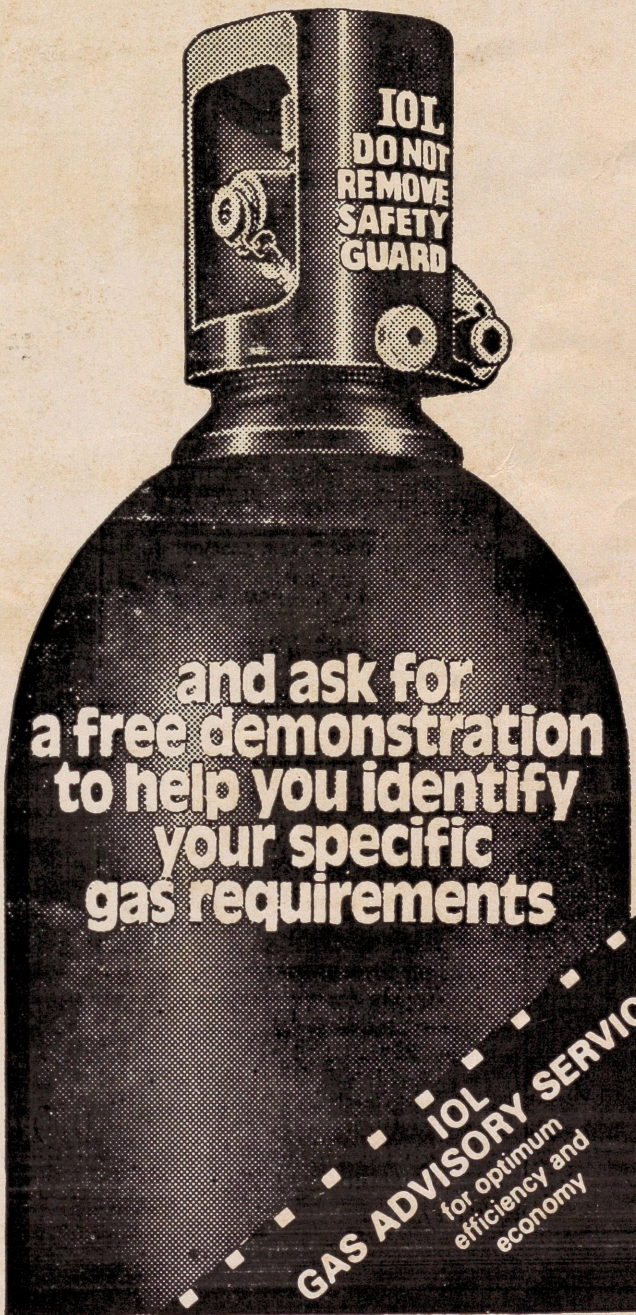
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The key nature of alchemists role in laying the foundations of modern science, may be judged from only a partial list of basic scientific tools, associated with their names.

Chemistry had its origin in the laboratories of the alchemists. Alchemy eventually expired

under the impact of science, but its tools and procedures were taken over by the scientists in the modern world, to utilize them for extending the basic discoveries still further and bringing them closer to the common man.

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