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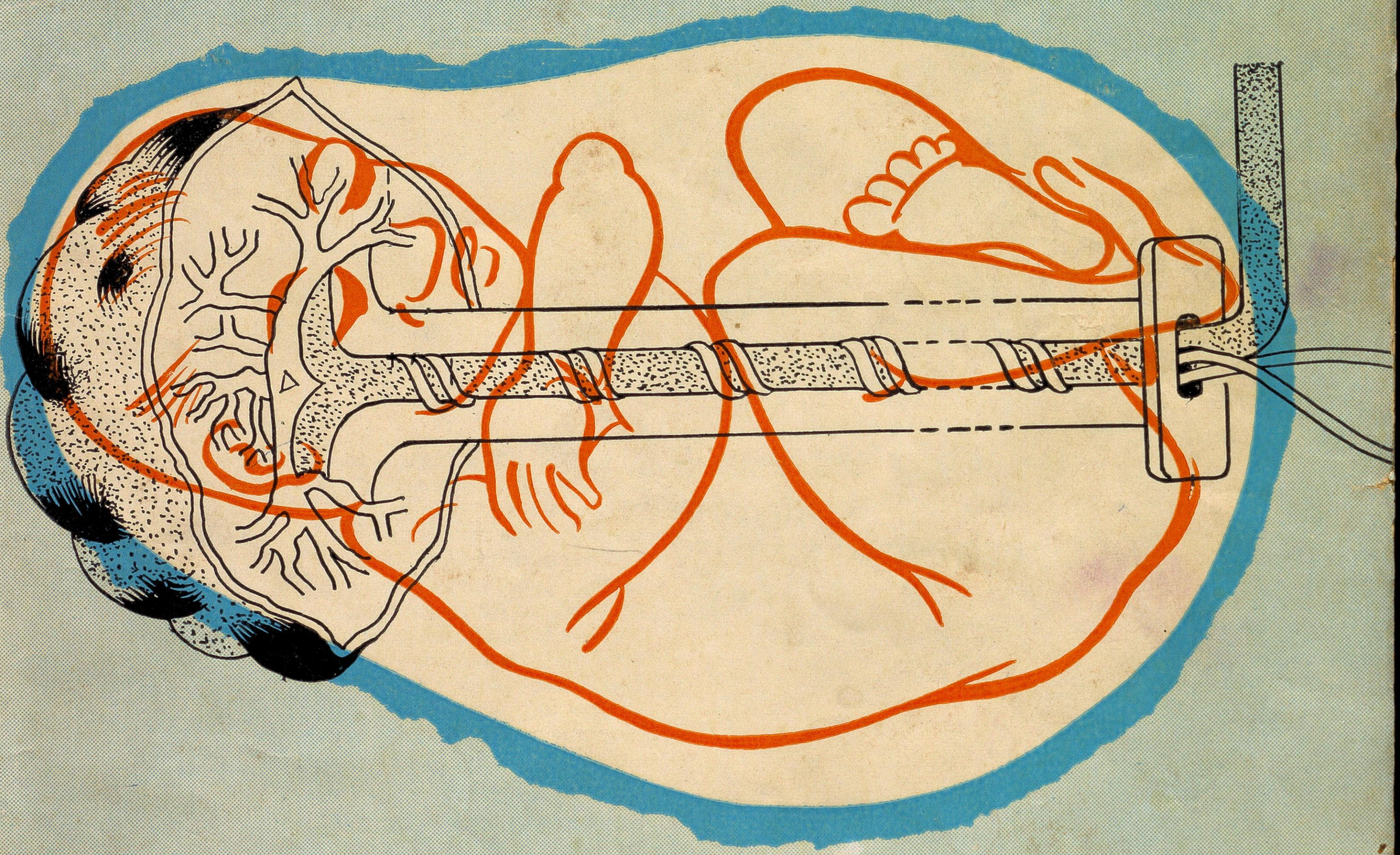

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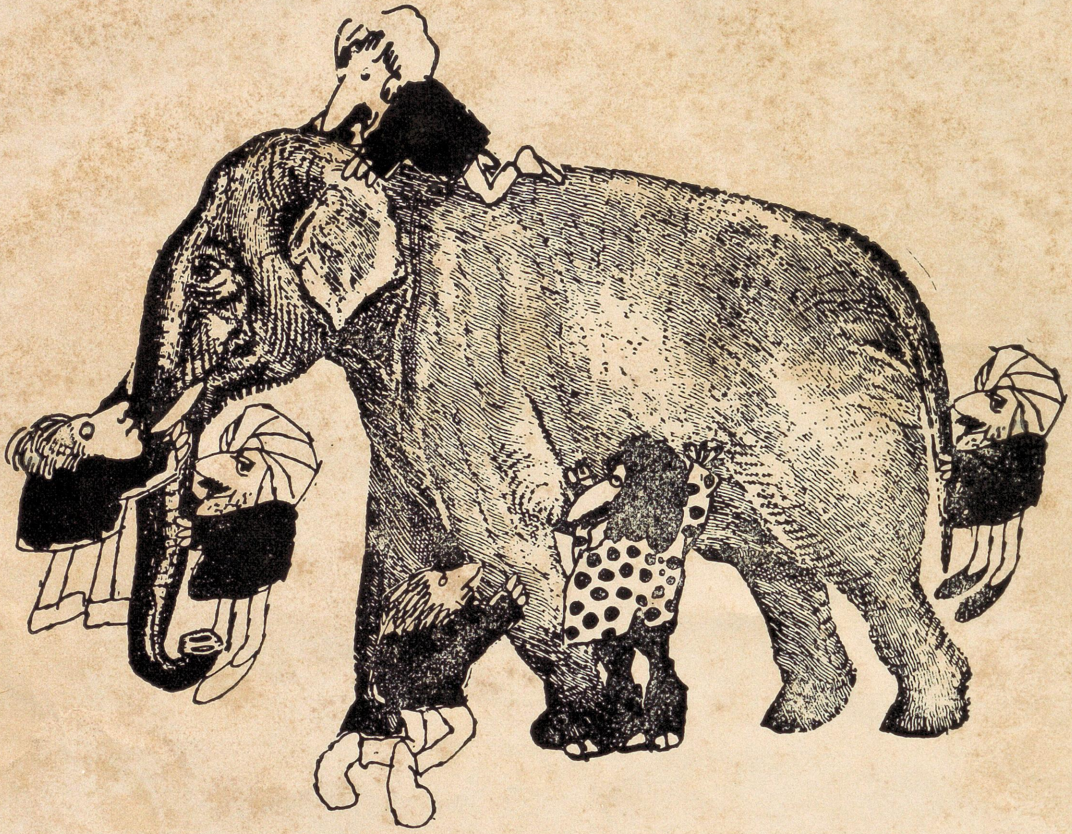

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LETTERS

Science Congress—1977

Sir, I was surprised to see that the Indian Science Congress session at Bhubaneswar in January 1977 was nothing more than a wastage of time, national wealth and science talent.

The report on the Indian Science Congress 1977 (*S.R.*, Feb. 1977) and also the report on the "Science Paper Reading Contest" by D. M. Salwi show that the so called "scientific temper" holds no water in our country. For example, the participants at Bhubaneswar were not scientists but tourists. Barring about half a dozen topics, everything at the science congress was dull and dry.

I feel that magazines like *Science Reporter* are much more useful than science conferences—especially for those who are interested in the advancement of science.

V. K. PANDIT
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Indore-452002 (*M.P.*)

Microwave sterilization

Sir, Re : **Hazards of microwaves** by Vijender Sharma (*S.R.*, January 1977). It has been mentioned that the microwave radiation causes sterilization. I think it would not be a bad idea if the family planning people do research on it and use it in their campaign. The villagers generally fear surgeon's knife and microwave sterilization will be a good substitute.

GHULAM YAZDANI KHAN
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Haldwani (*U.P.*)

Relativity and tachyons

Sir, The articles published in *S.R.* invariably give students confidence to follow the advanced courses in science and provide teaching staff adequate support for analysis and intelligent interpretation. I like to mention a few more points about **The riddle of gravitation** (*S.R.*, July 1976). Do the tachyons, the particles moving with a velocity greater than the velocity of light, invalidate Einstein's theory of relativity? Einstein's special theory of relativity accounts for only the continuous variation of physical properties of particles, but not the creation of new particles such as pair production. The sub-atomic particles such as mesons are easily created and destroyed. By mutual interactions they exchange their energies and other physical properties, where we cannot expect a continuous variation of any of its physical properties. We can also suppose the generation of particles already travelling faster than light, thereby we can avoid the need for accelerating them through the light barrier. It necessitates us to conclude that the hypothetical 'faster-than-light' particles can never be brought to rest. The velocity of light thus acts as a upper limiting speed for ordinary particles while for tachyons it acts as a lower limit. Now scientists are hunting for tachyons.

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Genetic code

Sir, Although Dr. Ryan's attempt in following the growth of molecular genetics in **The genetic code revisited** (*S.R., Feb. 1977*) was very successful, I would like to make some corrections, additions and comments.

It has been very well established that proteins are synthesized starting with their amino terminus and *m*RNA is translated starting with its 5′p end and the direction or polarity of both transcription (also DNA replication) and translation is the same—5′ to 3′ direction and not 3′ to 5′ as is mentioned in the article. This permits the initiation of translation while the transcription is still continuing, before the completed *m*RNA molecule has left its site of formation. In fact the polymerization proper, whether DNA replication or transcription is always by the accretion of a 5-deoxynucleotide or 5′ nucleotide to the free 3′-OH group of the growing chain, hence the direction would be always 5′ to 3′.

The usual convention of writing nucleotide sequence with 5′-C of ribose (or deoxy) sugar on the left and the 3′-C on the right as mentioned in the article is correct but it is desirable to add p. or OH on its right (e.g., 5′ p., 5′ OH, 3′ OH, etc.) as the case may be.

It will be more correct to say that a cistron of 1000 to 1500 base pairs in a definite sequence of DNA can direct the synthesis of a polypeptide (mol.wt. less than 6000 daltons) and not a protein as mentioned by Dr. Ryan. Because, the average minimum mol.wt. of protein is generally considered to be above 6000 daltons.

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The apparent disagreement over the direction of transcription is easily explained. Firstly, it is always essential to specify the template molecule in question; whether DNA or RNA. Certainly in most cases nucleic acid chains grow in the $5' \rightarrow 3'$ direction. However, in transcription when the *m*RNA is growing in the accepted $5' \rightarrow 3'$ direction it must follow from the sheer logic of complementarity (that is, by lining up the RNA formed and the corresponding segment of the DNA template) that the DNA sequence is being read in the $3' \rightarrow 5'$ direction during transcription.

Secondly (even though I did not review the significance of terminal groups), I agree that it is desirable to indicate them, not only for the sake of completeness but also because it is now known that DNA-polymerase acts as a repair enzyme; working in the $3' \rightarrow 5'$ direction if a 3'-OH but not a 3'-p terminus presents, and in the $5' \rightarrow 3'$ direction if either a 5'-OH or a 5-p terminus presents.

Lastly, I also agree that proteins in general contain more than the 500 amino acids implied, therefore in context the term polypeptide is preferable. But may I add an informative countercomment. The term dalton should not be used for molecular weights, which are pure ratios and hence dimensionless. However, there is no objection to using it for expressing molar masses, and the like. The dalton represents a mass of 1.663×10^{-27} kg or approximately one hydrogen atom.

JAMES PHILIP RYAN
University College of Dublin
Dublin, Ireland

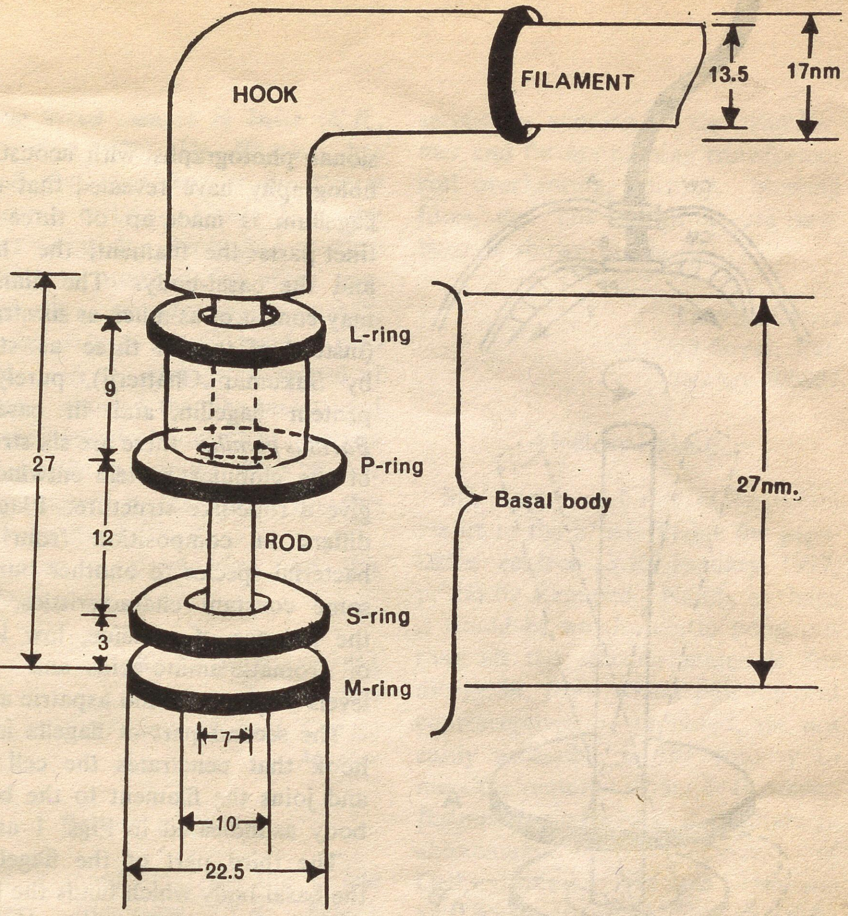

Fig. 1. Structural models demonstrating various parts and location of the basal structure of flagella in gram negative bacteria (*courtesy*: M.L. De-pamhilus & J. Adler)

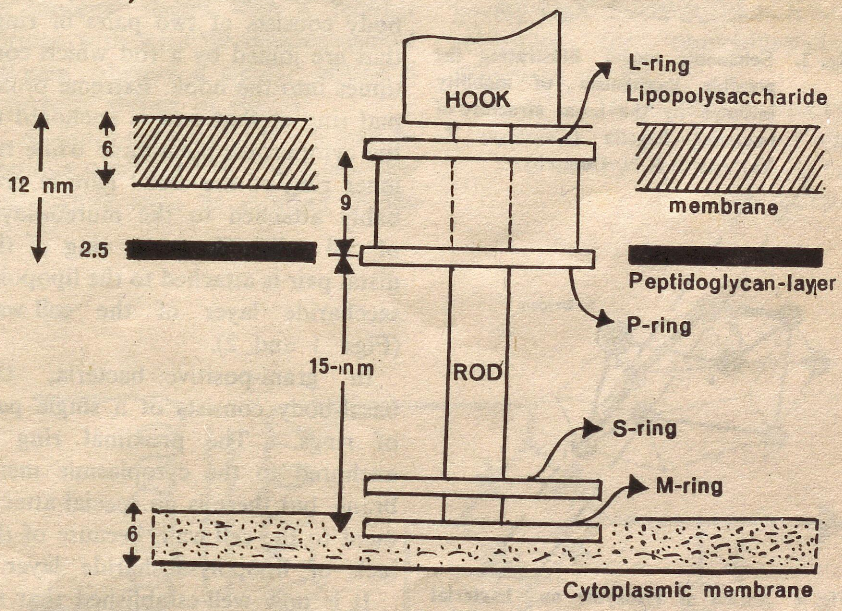

Fig. 2. Different parts and attachment of M-ring to the cytoplasmic membrane in gram-negative

Bacterial flagella

Sir, Thanks for the article **Bacterial flagella** by Sukumar Chatterji (*S.R.*, September 1976). As some statements are not uptodate, I would like to add a few new facts relating to the field.

According to Julia-Levy and his coworkers at the University of British Columbia, Vancouver, Canada (1973), diameter of each flagellum ranges from 10-20 nm and the length from 15-20 nm. Sukumar Chatterji writes that flagella contain only two or three tightly wound strands, while modern electron micrographs and three-dimen-

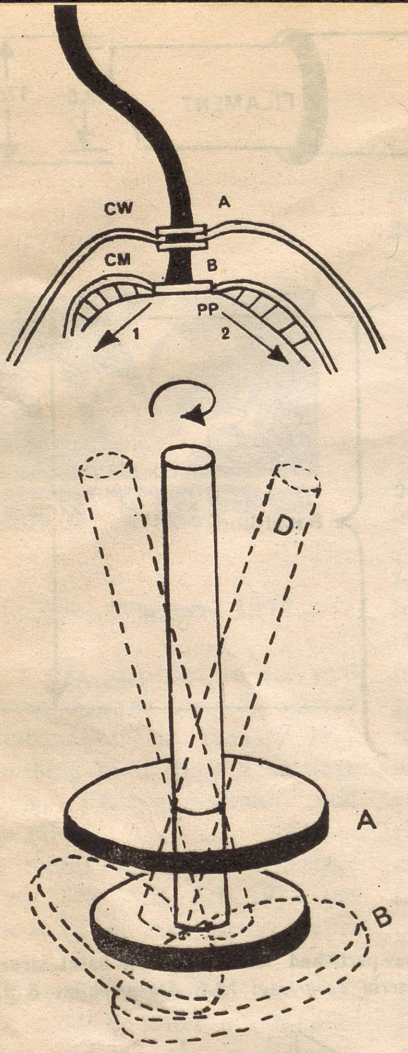

Fig. 3. Schematic model illustrating the possible mechanism of mobility initiated by the basal structure of bacterial flagella (*Courtesy*: Z. Valtuzis & R.N. Doetsch)

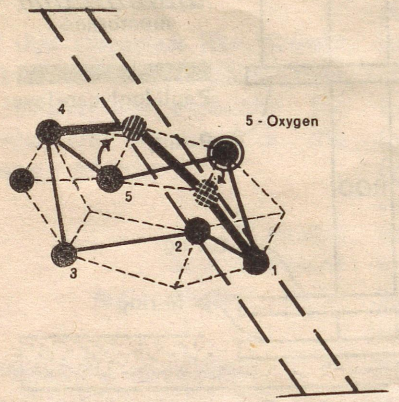

Fig. 4 Action of lysozyme on bacterial cell-wall. Chair conformation is that normally assumed by the rings of aminosugar in the polysaccharide-substrate. When bound against the lysozyme, however, the D-ring is distorted (dark-black thick lines) so that C-atoms 1,2,5 and O-atom-5 lie in a single plane. The distortion eventually assists in breaking the substrate below the E-ring

sional photographs with acoustical-holography have revealed that each flagellum is made up of three distinct parts: the filament, the hook and the basal-body. The filament may consist of as much as six strands (instead of two or three as stated by Sukumar Chatterji), purely of protein flagellin, and in case of *Bacillus pumilus* there are six strands of the globular protein entwined to give a rope-like structure. Flagellin differs in composition from one bacterial species to another but has some constant characteristics, e.g., the absence of cysteine, low levels of aromatic amino acids and high levels of glutamic and aspatric acids.

The second part of flagella is the hook that penetrates the cell wall and joins the filament to the basal-body as indicated in Figs. 1 and 2.

The third part of the flagella is the basal-body which binds the hook and the filament to the cytoplasmic-membrane.

In gram-negative bacteria, basal-body consists of two pairs of rings that are joined by a rod which continues into the hook. Extreme proximal ring of that pair is anchored to the cytoplasmic membrane while the inner ring of the distal pair is probably attached to the murein-layer of cell walls. The outer ring of the distal pair is attached to the lipopolysaccharide layer of the cell wall (Figs. 1 and 2).

In gram-positive bacteria, the basal-body consists of a single pair of rings. The proximal ring is anchored to the cytoplasmic membrane, but there is no special attachment to the cell wall, because of the lack of lipopolysaccharide layer.

It is now well-established that no cytoplasmic granule-like structures, previously thought to be the origin of flagella, exist in the cytoplasm. When the cell wall is dissolved by antibiotics or lysozyme (Fig. 4), the estreme proximal M-ring of the basal body of the flagellum remains attached to the membrane.

According to Z. Valtuzis and R.N. Doetsch (*J. Bacteriol.*, 100: 512, 1969), the motion of the flagellum is initiated by a wobbling-action of the basal disc that is embedded in the cytoplasmic membrane (Fig. 3). The hook transmits these undulations to the filament to give a cone of revolution. The gyrating filament drives the cell forward. This theory accounts for the essential nature of the cell reactions in the filament.

(MISS) ANJANA SHARMA
ARVIND KUMAR RAI
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Leather in many forms

Sir, I read **Leather in many forms** by N. Santappa (*S.R.*, November 1976) with great interest.

1. What is polyurethane finish ?
   (a) What are the materials required?
   (b) Are materials available in the Indian market?
   (c) What is the basic process?
2. Is there any difference between patent finish and glaze finish ? If yes, please give details as asked for in question No. 1 taking into account glaze finish.
3. Often embossing is made to hide grains. Is there any other way to hide them?
4. Please name any book available in the market on various types of finishing with full details of processes.

SYED AHMED SHOAA
71/1, Colootola St.
Calcutta-700073

1. It is a type of finish, applied after the tanning, fatliqouring and dyeing operations in order to impart an aesthetic look and also to pro-tect the leather surf

vagaries of weather. In such finishing operations polyurethanes form one type of finishing agents.

(a) Normally bio-or polyfunctional isocyanates and polyhydroxy esters like organic polyesters are used in the preparation of polyurethanes. But tanners can obtain ready-to-use polyurethane compounds which can be used in solvents or in emulsions.

(b) Ready-to-use polyurethane finishes are available. Polyesters are also available but not isocyanates to our knowledge.

(c) The process involves addition of isocyanates slowly to the moulten polyurethane, diluted with solvents like M.E.K. under reflex at about 60°C temperature.

2. The patent finish and glaze finishes are different. Polyurethane finish is also known as patent finish. In old days patent finish was based on linseed oil lacquer. For glaze finish materials such as protein binders (casein, egg yolk, blood, pigment dyes, formaldehyde, etc.) are made use of. Materials for glaze finish are available indigenously.

The process for preparation of pigments is the same as used in the preparation of pigments applied to textile industry.

3. Patent finish is another way of hiding the grain defects apart from metallic finishes and transfer foil finishes.

4. (1) *Modern Theory & Practice of Leather Manufacture* by K. T. Sarkar, A. M. Sharif, 555, Ponamallee High Road, Madras.

(2) C.L.R.I. publications on various types of leathers, are obtainable from the Director, Central Leather Research Institute, Madras-20.

C. KOTESWARA RAO
Scientist
C.L.R.I., Madras-20

Weed menace in India

Sir, Many thanks to V. Bhaskar for his interesting and informative article **Weed menace in India** (*S.R.*, November 1976). Dr. Bhaskar has stated that according to the Forest Research Institute, Dehra Dun, the insect used for biological control of lantana attacked the other economically important species as well. But recently a school teacher who worked on the biological control of lantana showed that the insect used for the biological control of lantana was specific to lantana. This teacher was awarded a cash prize for this work by the I.C.A.R.

I need a clarification on this point.

K. L. MAHADEVAPPA
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Battery eliminator

Sir, I thank you for the article **Battery eliminator** (*S.R.*, March 1977).

The circuit given in Fig. 4 (ii) is however shown with a rectifier bridge with wrongly inter-connected diodes, whereas a similar bridge is correctly shown in Fig. 5.

A minor error as such will lead to serious problems to the home experimenter such as shorting of the secondary winding of the transformer and further causing transformer coil overheating, burning, blowing fuses, etc. The bridge should have been as shown in Fig. 1.

TREVOR LEWIS
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Bombay-400001

Medicinal plants

Sir, Apropos of role of medicinal plants in the article **Plants for population control** (*S.R.*, January 1977, p. 39) by Renupada Nandi, perhaps it would be worthwhile to point out that all the starting materials for diosgenin, from which pills for oral contraceptives are prepared, are not easily accessible in the country to meet the required demand. However, *Balanites roxburghii* is found in abundance in arid zones of Delhi, Sikkim, Western Haryana and South India. H. S. Puri (*S.R.*, May 1976, p. 289) stated that the yield of diosgenin from this source is very high. Evidently, it is a better substitute for diosgenin-yielding *Dioscorea* species.

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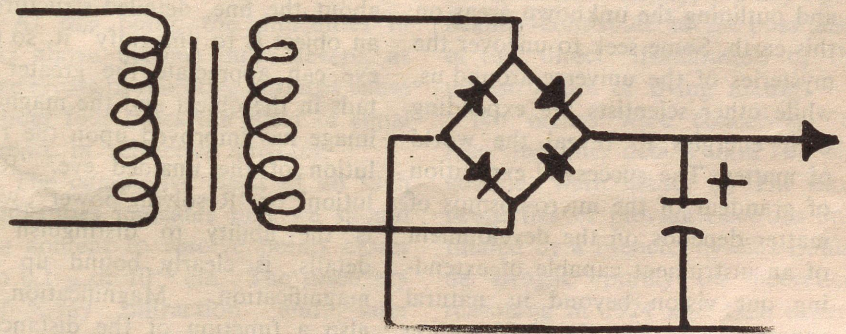

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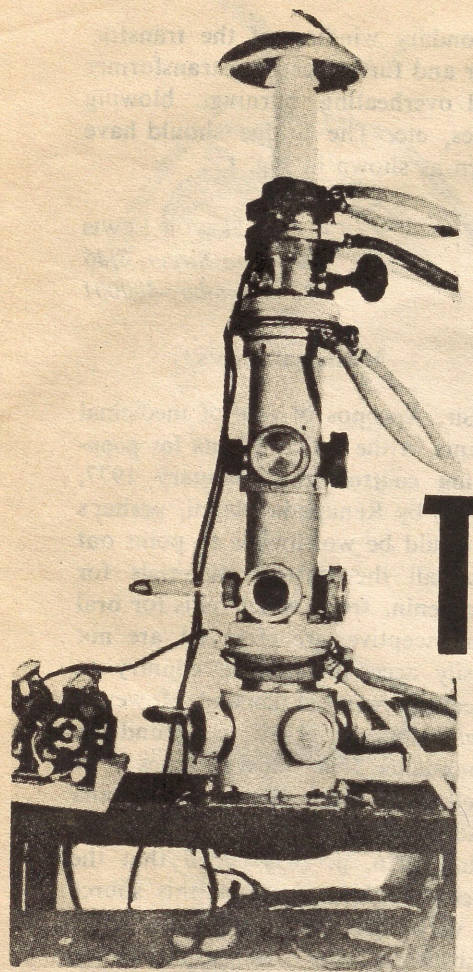

THE ELECTRON MICROSCOPE

How did it evolve?

The light microscope reached perfection after more than two centuries of development. The electron microscope reached the comparable level in a short span of two decades

ANIL VISHNU MOHARIR

IN this twentieth century, the term "explorer" can readily be applied to scientists than to those who are engaged in conquering and outlining the unknown areas on this earth. Some seek to uncover the mysteries of the universe around us, while other scientists are expending their energies to reveal the world of matter. The successful exposition of grandeur of the micro-cosmos of matter depends on the development of an instrument capable of extending our vision beyond its natural capacity, so that the information secured can be appreciated by our sense of vision, which is man's most important faculty for the understanding of his environment.

It is a common knowledge that the simplest way to find out more about the fine, detailed structure of an object is to "magnify" it, so that eye can appreciate the greater details in the object and the magnified image has improved upon the resolution of the unaided eye. "Resolution" or "Resolving power", which is the ability to distinguish fine details, is clearly bound up with magnification. Magnification is also a function of the distance of an object from the eye, and as the object is brought closer to the eye, more of the detailed structure can be resolved. Under the best conditions, an unaided normal eye can resolve a distance of about 0.25 mm at 25 cm, which is the least distance of distinct vision. It cannot separate smaller details because of the limits of resolution of the eye lens and the granular structure of the retina which is made up of cells of finite width. It is therefore clear that magnification alone cannot show details. The answer lies in the understanding of the fundamental physical nature of light: it is an electro-magnetic wave motion and the waves are of finite length.

Shri Moharir is Asstt. Physicist (EM), Nuclear Research Laboratory, Indian Agriculture Research Institute, New Delhi-110012.

Man invented first the simple microscope from the magnifying glasses around 1300 A.D. The compound microscope was the magnificient contribution of 16th century towards this goal of the exploration of matter.

Two centuries later, the introduction of the glass lenses corrected for the intrinsic optical defects like chromatic and spherical aberrations, astigmatism, brought the light microscope to its 'peak' of perfection. And in the concluding process of development of this instrument, Sir George Airy in 1834 conclusively showed, basing his calculations on the wave theory of light, that the limit of close approach for two points in the object, consistent with the possibility of distinguishing their images, is known to be given approximately by

$$\text{Resolving limit} = \frac{0.61\lambda}{N \sin\alpha}$$

where

λ = wavelength of light

N = refracting index of the medium in which the object is situated

α = the semiangle between the axis and the most oblique ray from the axial object.

N Sin α is also called "Numerical aperture."

However, in our pursuit of securing an indefinitely high resolution by using shorter wavelengths, many difficulties are encountered, which are as follows :

1. The surfaces of the optical system must be perfect in both their figure and polish.
2. The optical materials should be perfectly homogeneous.
3. Since air does not transmit radiations beyond 0.18 μ, vacuum- or nitrogen-filled instruments become necessary.
4. The usual refracting media become opaque to the increasingly shorter wavelengths and this requires the use of reflecting instruments.

At this point, the difficulties in (1) above become more severe, as the errors in reflecting surfaces cause about four times the effect of equal errors in refractive surfaces.

The cumulative effect of all such difficulties indicates that we should be content to resolve points closer to 0.1 μ or 10^{-5} cm. The discovery of X-ray diffraction and later the electron diffraction mitigated this trouble. Convenient X-ray wavelengths range from 0.5-2.0 Å i.e., they are four thousand times smaller than that of light waves, but unfortunately lenses for refracting X-rays cannot be realised.

In 1878, Ernst Abbe, in opposition to many contemporary scientists, expressed the view that optical technology had reached a fundamental limit and no further improvement in resolution was possible. He even declared light as a wave motion, whose half wavelength marked an impenetrable limit of resolution for any optical magnifier at about the quarter micron level. Abbe was sure in his mind that a new form of radiations of short wavelength was needed to improve resolution and possibly see the molecular and atomic phenomena. He also declared that a new form of microscope, if it ever emerged, would have little more in common with them than the name. Time has proved that Abbe was quite correct in his resolution limit postulate, but incorrect in his prediction regarding the nature of an ultramicroscope. The later introduction of the polarisation, dark field, phase contrast and fluorescent microscopy during the first half of the twentieth century, did not significantly contribute to the possibility of the direct visualisation of the ultrastructure of living matter.

No means were conceived of resolving finer details until two discoveries were made: (i) The wave properties of moving electrons postulated by a French Physicist Louise de Broglie purely on theoretical reasoning in 1924 and their experimental verification in 1927 by C. J. Davisson and L. H. Germer of Bell Laboratory in America and G. P. Thomson and Reid in Eng-

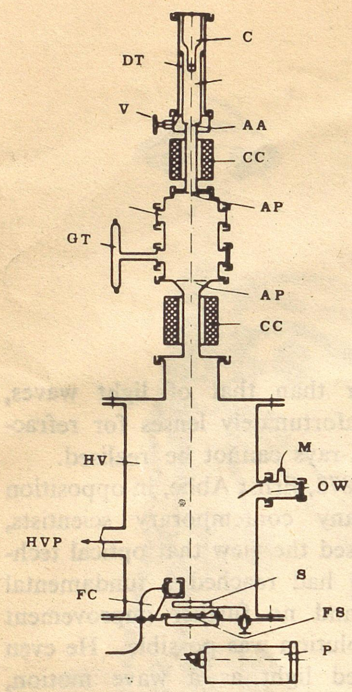

Fig. 1 Line diagram of Electron Optical Test apparatus of Knoll & Ruska used to demonstrate the principle of EM. AA: anode aperture, AP: aperture, C: cathode, CC: concentration coil, DT: gas discharge tube, FC: Faraday cage for measuring beam current, FS: Fluorescent screen, GT: Geissler tube, HV: Region high vacuum, HVP: to the high vacuum pump, M: connection to measuring equipment, OW: observation window, P: Photo-apparatus S: observation screen, V: air inlet valve

land, and (ii) the discovery by H. Busch (1926-27) in Germany of the similarity between the effect of a magnetic coil on an electron beam and the effect of a convex lens on a light beam. Since the wavelength of a moving electron is smaller by many orders of magnitude than the shortest wavelength of electromagnetic radiation, these discoveries made it conceivable that extremely small objects might be imaged with an electron beam and electron lenses (The wave length λ for a moving electron according to de Broglie relation is given by $\lambda = h/p$, where h is the Planck's constant and $p=m$ x v, the momentum of the electron of mass m and velocity v. For an electron accelerated to 60 KV, the wavelength is about 0 .05 Å).

The remarkable feature associated with the development of the electron microscope is that while light microscope reached its peak of perfection after more than two centuries of development, the electron microscope reached a comparable level in a short span of two decades. The electron microscope represents thus one of the twentieth century's contributions to this never-ending goal of seeing the atoms and molecules of matter at work.

The history of the development of the electron optics starts more or less with the discovery of the cathode rays and subsequent experiments on cathode rays that conclusively brought to rest the controversy over the corpuscular nature of electrons. E. Weichert (1899) in Germany made the first intentional use of a solenoid for concentration of the cathode rays. In 1903, H. A. Ryan used a short solenoid for the purpose of focussing cathode rays. This work was taken up for further investigations by C. Stöermer who performed a series of extensive experiments and calculations on the trajectories of charged particles in fields, and derived the most basic fundamental equations. In an attempt to apply the results of these investigations and the laws to certain practical scientific and engineering problems, that the subject of "electron optics" was born. However M. Knoll and E. Ruska, in two of their papers published in *Annalen der Physik* in 1932, were the first to use the term "Electron optics."

In 1926-27, H. Busch working in the Physical Institute Jena (Germany), made a theoretical analysis of the action of concentrating coils in which he developed the most fundamental formulae of magnetic electron optics. He subjected these formulae to rigorous experimental checks and found a good agreement between his experiments and theory. The differential equation of the trajectory of an electron developed by Busch is a lens equation, which shows that the angular change in the direction of motion is proportional to the displacement from the axis. If the electrons form a beam with a definite convergence at any Z planes, they will remain a beam at all Z planes. Axially symmetric electric and magnetic fields therefore constitute lenses for the electrons.

H. Busch, however, did not develop formulae for electrostatic lenses, although it is implicit in his equation that the second derivative of the electrostatic potential has a focussing effect similar to that of a magnetic field. Later C. J. Davissan, and C. J. Calbick and E. Bruche and H. Johnnson, in 1931-32, independently demonstrated that symmetrical electrostatic fields could also be used as electron lenses. However, the use of electromagnetic lenses for the projection of extended electron images was first developed by M. Knoll and E. Ruska in 1931, when they extended the iron encapsulation on the focussing coils and thereby shortened the magnetic field and reduced the number of ampere turns required for a given focal length. Knoll and Ruska succeeded in magnifying the electron image formed by the first solenoid by means of a second solenoid placed between the intermediate image and the final screen. The magnification obtained was only seventeen times, nevertheless the basic principles of electron optical magnification had been established.

M. Knoll and E. Ruska were also the first to introduce small apertures for controlling spherical aberrations. The results of these experiments together with electron micrographs of simple objects like the circular and T shaped, multiple apertures, metal meshes, etc., were presented by Knoll on June 4th 1931 at a Crantz Colloquium at the Technische Hoschule, Berlin. (see also box column). These experiments proved that the aberrations of magnetic lenses could be made very much smaller than Busch and practically all other scientists had expected, and that a good resolution was indeed very much within reach. Knoll and Ruska had not even applied for a patent until then. They however followed up their demonstration with a paper *Beitrag Zür geometrischen Elektronenoptik*, that was submitted for publication on the 10th September 1931. This paper is one of the most comprehensive in electron optics theory. Thus the credit for the invention of the electron microscope goes. to M. Knoll and E. Ruska. They were then working at the High Tension Laboratory of the Technical University at Berlin, under Dr. A. Matthias who was then its Head. The development of the electron microscope was actually a byproduct of their work on demountable cathode ray oscillographs, which were being used for the investigation of lightning and other surge phenomena. In 1928, Max Knoll was transferred to the technical University, where a separate electronics laboratory was established for him and he was made its Head. Working in close cooperation with a small group of selected students, he started directing basic research on electron beams and cathode ray oscilloscopes. Knoll divided the main research programme into various related fields ; each forming the doctoral research work of his students. The researchers and their main fields of investigations were: (a) M. M. Freündlich : "Hot cathode electron source and trigger and time base circuits"; (b) H. Knöblach: "The cold cathode electron source"; (c) E. Ruska: "Beam focussing"; (d) H. von Börris:" "Photographic recording methods'; and (e) H. G. Lubszynski: "Electromagnetic shielding:"

M. Knoll left the field of investigation in 1932 but Ruska carried on. By 1933 he had designed a new electron microscope, the real forerunner of the present day machines. This was constructed by incorporating the idea of von Börris of providing "pole pieces" to concentrate the magnetic field into as small an axial region as possible; and the simple idea has dominated the field of electron optics ever since then. The achievement of a resolution of 500 °A was claimed with this new instrument by observing the charred remains of the organic specimens.

In Belgium, G. A. Morton, of the University of Brussels, did much of the early work in the biological application of electron microscope. He proposed thinner specimens, higher accelerating potentials and internal photography leading to short-exposure times. These ideas were incorporated later and a new electron microscope improved in many features over its previous instruments was constructed in 1935. The maximum accelerating potential was increased to 100 KV, and specimen and camera airlocks were fitted for the first time in the instrument. These airlocks have made a decisive contribution in the design and practical operation of electron microscopes. Today, with the growth and advancements of several new techniques used for the preparation of specimens for electron microscopy, the electron microscope has become an indespensable tool for any biological research.

The work of Knoll and Ruska had triggered off experiments in electron optics in almost all the industrially advanced countries of the world. The first commercial electron microscope EM1 was built

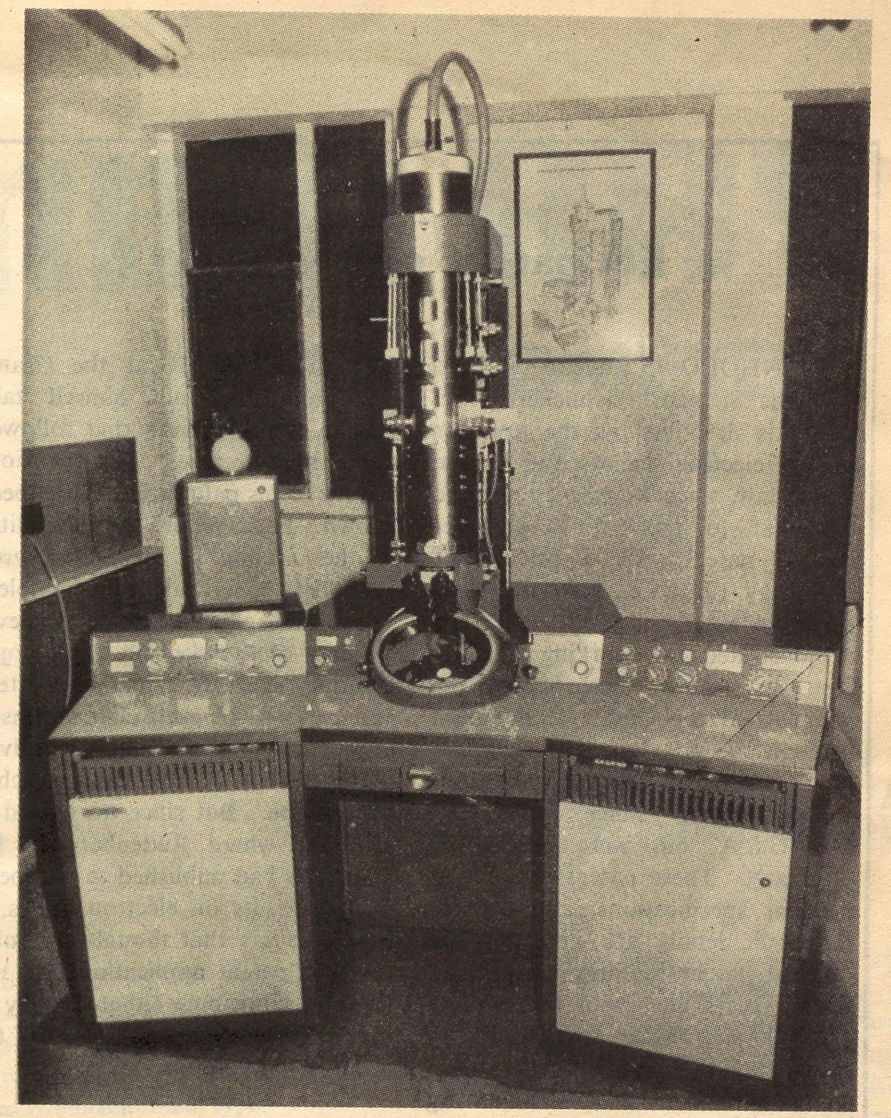

Fig. 2 Modern versatile Phillips EM-300 elcctrone Microscope with, resolving power better than 5 Å

by the Metropolitan Vickers Electrical Company for Professor L. C. Martin at the Imperial College London in 1935. However, the series production of electron microscopes had begun in 1938 by the firm "Siemens Halske", Germany, under E. Ruska and B. von Börris. In 1941, R.C.A. model B in America was accomplished by V. K. Zworykin, J. Hillier and E. G. Ramberg, with many advanced features such as electronically stabilized accelerating voltages and lens current supplies. In 1940, M. von Ardenne in Germany is reported to have had produced a universal electron microscope of advanced design with a resolution of 30 Å. Facilities for producing dark field and stereo images were incorporated and for the first time a second condenser lens was introduced by means of which a fine electron probe of less than one micron in diameter could be focussed on to the specimen. M. von Ardenne also wrote an excellent comprehensive book in 1940 that helped the rapid expansion of electron microscopy. In 1945, electron microscope with three stage imaging system was built by G. A. Morton and associates at the Stanford University, which greatly increased the range of magnification. At about the same time J. B. Lé Poole of the Institute for Electron Microscopy Delft, Netherlands, had independently arrived at the principle of the intermediate projector lens as a means of extending the range of magnification.

The most recent growth of electron optics has been stimulated by the demands of nuclear physics. The electron spectrometers of high resolving and collecting power, the techniques of particle acceleration, etc., have all favoured the development of electron optics in the relativistic region of highest electron velocities.

Commercial models of electron microscopes of varying features are now available from several manufacturers and the highest resolution that can be achieved with a modern versatile machine is 2.5 Å in the crystalline specimens and about 10 Å in biological specimens. Also, the modern electron microscopes are being increasingly made automatic in operation except the actual screening. Moreover, the single equipment with the help of requisite accessories can perform stereo, dark field and normal transmission electron microscopy, electron diffraction, and X-ray elemental analysis of the specimen of interest, and also the scanning electron microscopy. In short, these are most versatile in their design and operation and unless a thoroughly trained man is at the helm of affairs of an electron microscope laboratory the smooth functioning and maintenance of the microscope is a very costly affair. Although the microscope, unlike other scientific equipments, has been designed to increase the angle of vision, its purpose is to take the faculty of sight into a completely new world which only a skilled electron microscopist can interpret.

In the gap between the upper limits of molecular level and lower limit of resolution of the light microscope lies the answers to most of our fundamental problems of technological, biological and medical significance. Let us see how man succeeds to solve them.

(*Continued on page 294*)

EM patent controversy

REINHOLD Rüdenberg, of the Siemens Schuckertwerke, Berlin is described as the inventor of the electron microscope in the Patent law, since Rudenberg was the first man to apply for a comprehensive patent with a priority of 31st May 1931, i.e., only five days before Max Knoll and E. Ruska demonstrated the working of their first ever electron microscope to the scientists at the Crantz Colloquium held on the 4th June 1931. Rüdenberg's patent applications were granted in Austria, France, Switzerland and U.S.A. but were refused in Germany. These patents are broad in their specifications, although no technical details are given. The German patent was, however, granted twenty years later with the original priority and Max Knoll and E. Ruska are the users of this patent. It is known that R. Rüdenberg although attended Knoll's lecture on the 4th June 1931 at the Crantz Colloquium, did not himself take part in the discussion that followed after the lecture. The curious history of his patents has never been known. In a letter to the Editor of the *Journal of Applied Physics* 1943, **14**, 434, Rüdenberg has pleaded for his association with the development of the electron microscope. Quoting excerpts from his patent applications, he even claims himself to be the man who first conceived the possibility of constructing such a microscope. But since no record is available where Rüdenberg or his associates had published their experimental results on electron optics, it is safe to say that though he, holds the first patent application, did not however contribute either directly or indirectly to the development of the electron microscope.

A.V.M.

GAMMA RAY SPECTROMETER

It is the extremely high resolution capacity of the Ge(Li) detector which makes it preferable to a scintillation detector

K. VENKATA RAMANIAH
K. VENKATA REDDY

THE use of lithium-drifted germanium detectors has revolutionised the gamma ray spectroscopy in the last few years. It is the extremely high resolution capacity of the Ge(Li) detector that distinguishes it from and often makes it the detector of choice over the scintillation detector. The optimised Ge(Li) detector usually produces resolutions between a factor of ten and twenty better than NaI (Tl) scintillation detectors over most of the energy range of interest.

The two old methods of energy measurements of nuclear radiations, viz., the organic or inorganic scintillation spectrometers or gaseous ionisation chambers and the bent-crystal spectrometers, represent two extremes in quality of performance and cost. Systems involving the former methods are less expensive but poor in resolution. The solid-state detector Ge(Li) possesses to a great extent the high quality performance of crystal diffraction spectrometer and to some extent the conventional type.

There are primarily four types of Ge(Li) detectors in use today; (i) the thin window x-ray detector, (ii) the planar detector, (iii) the cylindrical symmetric or coaxial detector, and (iv) the single open ended circular or tropozoidal detector. The largest commercial single germanium detector currently available is of about 400 cm^3 volume as against the 350 cm^3 for the $3'' \times 3''$ long NaI(Tl) detector. The very narrowness of the peak upon a relatively featureless background helps us in distinguishing it. In this sense, greater resolution can substitute for greater absolute efficiency in the detection of the presence of a particular gamma ray. It is, for instance, not at all common for several gamma rays to be found where one was suspected from scintillation measurements. High resolution also implies, if adequate calibration is possible, more precise energy measurements of gamma transitions. The combined effects often make it possible to assign levels and branching ratios in complex gamma decay schemes on the basis of single spectrum (not involving coincidence studies) alone to a much greater degree of certainty that is normally possible with scintillation detectors.

The Ge(Li) detector influenced the expansion of multichannel analyser to a large number of channels. The energy and the intensity data, which can be obtained with careful experimental techniques, are refining the precision to which nuclear energy levels are known and as a consequence will eventually help to bring

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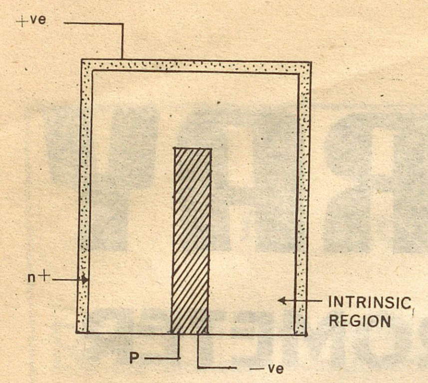

Fig. 1. A vertical section through a Ge(Li) detector. The hatched areas represent the P-type of material and clear portions represent the compensated region of lithium drift T

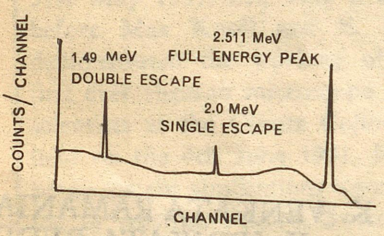

Fig. 2. Typical spectrum for incident gamma energy of 2.511 MeV

about the next phase in the refinement of nuclear theory.

Not only are these detectors playing a major role in the nuclear energy level and decay scheme area, but are also assuming an important role in almost every branch of natural sciences. Their use in activation analysis is readily acknowledged. An area where they are of major importance is the biomedical and environmental studies. They are also being used in certain branches of criminology and geophysics. Their ability to resolve many constituents in a complex mixture of radio nuclides, where concentrations differ considerably, has led to the elimination of many tedious and time consuming chemical separations. This is of particular importance in the analysis of both very short and long half-life fission products. Such products occur in nuclear reactor fuel elements, and an analysis of the locations of the various fission products leads to their better understanding. Eventually a more efficient element can be developed for reactors. These are a few of the many disciplines and areas in which Ge(Li) detectors are important.

The basic principle of operation of a solid-state detector is the same well-known principle of the ionisation chamber, the medium of detection is gas or air. It is possible to use single germanium crystals as detectors due to the process of lithium drift. The drifting of lithium produces an intrinsic region in which the acceptors and the donor atoms are effectively compensated. This situation will remain so as long as the devices are maintained at reduced temperatures. A Ge(Li) detector consists of an (n-i-p) junction device prepared by careful process decribed below.

The first step is usually the preparation of a cylindrical piece of high quality germanium by zone refining techniques. The next step is to diffuse lithium ions into germanium so that n-type region is formed. The lithium ions are then allowed to drift towards the central core under the influence of intense electric field. The whole process is controlled carefully. The drifted ions of lithium are effective in compensating for, or neutralising the p-type impurities in the germanium and then give rise to a region of intrinsic or high resistivity material. A typical cross-section of a Ge(Li) detector is shown in Fig. 1. The intrinsic region forms the active volume of the detector where the ionising radiations (gamma rays) create hole-electron pairs which are collected by external electric field.

Back biasing the P and N junctions of the diode permits the collection without multiplication of all charge carriers, that is, electrons and holes are formed in pairs in the intrinsic region. The detection of gamma rays proceeds as with all detectors with one of the three types of primary interaction, namely, photoelectric effect, Compton effect, or pair production, resulting in the gamma ray giving all or part of its energy to the kinetic energy of an electron or electron-positron pair. In the photoelectric process the gamma ray or X-ray gives all of its energy to the recoil electron. It is the recoil electron that produces the electron-hole pairs in the detector

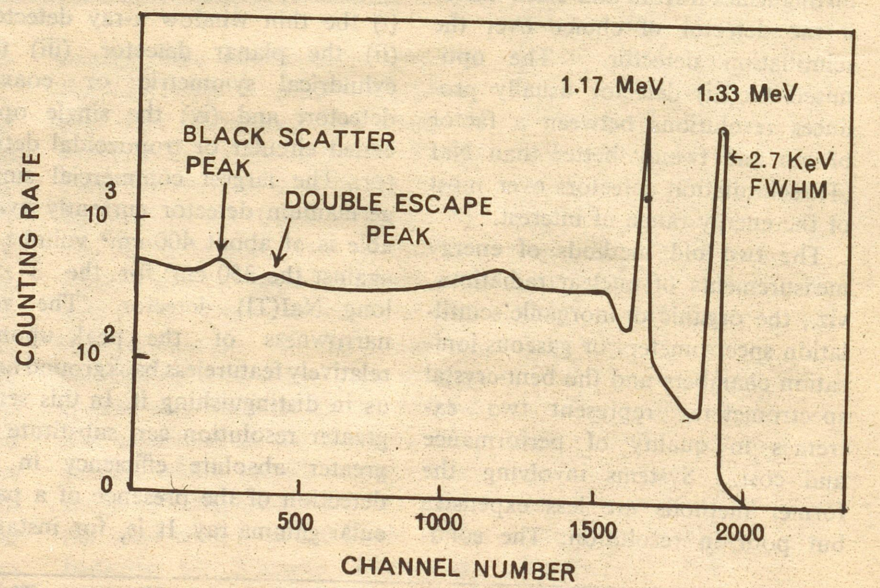

Fig. 3. Typical gamma ray spectrum of ^{60}Co with a Ge (Li) spectrometer

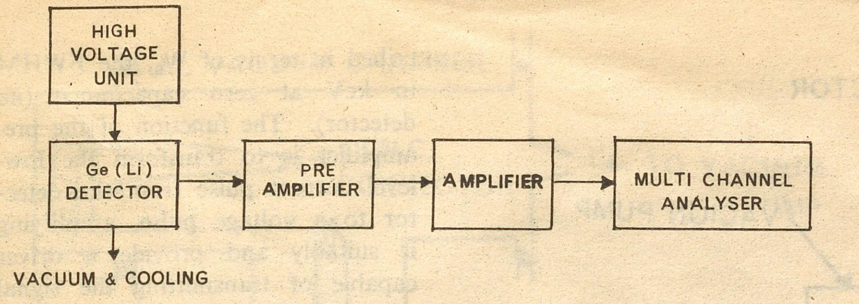

Fig. 4. Block diagram of the electronic system

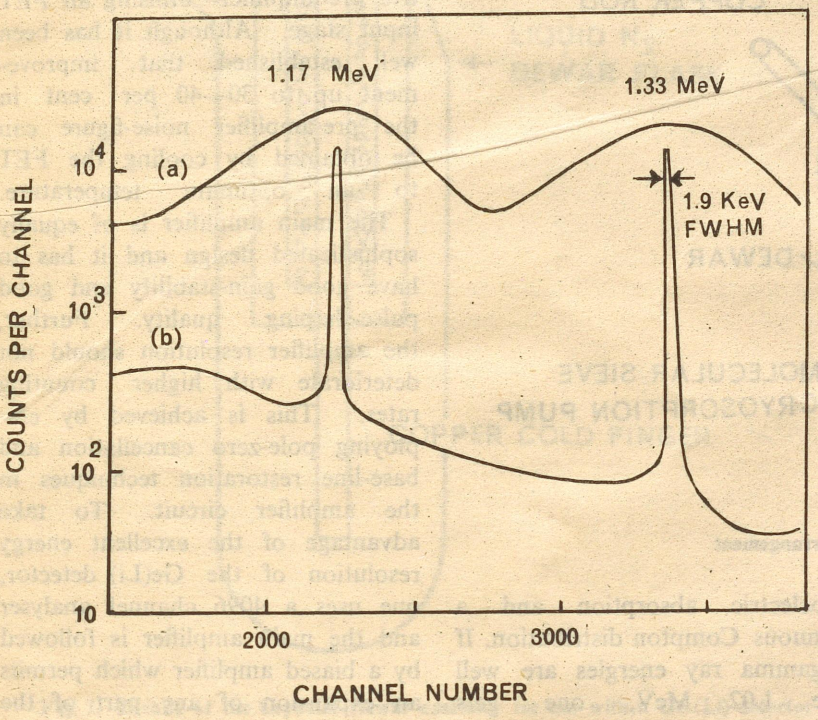

Fig. 5. Gamma ray spectrum of ^{60}Co: (a) with NaI (Tl) scintillator, and with (b) ORTEC Ge (Li) detector

to yield the output pulse. For the photoelectric process, the output pulse from the detector is proportional to the energy of the gamma or X-ray that produced the interaction. In the spectrum these events will show up as photo peaks. In the Compton process there is a distribution of the pulse amplitudes upto some maximum pulse height. This maximum pulse height produces the Compton edge and there is a statistical probability that each event can produce a pulse with any height upto this maximum with about an equal chance. Thus Compton events will provide a well distributed low-energy area in the spectrum as shown in Fig. 2. The pair production process can also provide a total absorption of the gamma ray energy. The gamma ray enters the detector and creates an electron-positron pair. From the law of conservation of mass and energy it follows that the initial gamma ray must have an energy of atleast 1.02 MeV, because it takes that much energy to create both the negative and positive electrons. The net mass that is produced is two electron masses, and this satisfies the law of conservation of energy, $E=mc^2$. The negative electron will produce a pulse whose magnitude is proportional to the energy of the $e^-(E_e^-)$. The postiron will produce a pulse proportional to (E_e+). Since these two pulses are produced simultaneously, the output pulse will be the sum of the two pulses. When the positron is annihilated in the detector, the annihilation radiation γ_1 and γ_2 will be produced. It is possible for only one, γ_1 or γ_2, to make a photoelectric interaction in the detector. In such cases the total energy absorbed is 0.511 MeV less than the original incident gamma energy. It is also possible for both gamma energy to produce photoelectric interactions without escaping, with all the original energy then being left in the detector. Therefore in the spectrum that is measured, there will be three peaks for each gamma energy. These peaks are labelled full-energy peak, single-escape peak, and double-escape peak, and they will be separated by 0.511 MeV increments. Fig. 2(a) shows a typical spectrum that would be obtained for an incident gamma ray energy of 2.511 MeV by using a biased amplifier to eliminate the lower energies and to expand the distribution of the higher-energy pulses across the range that is measured. The single escape peak occurs at (E–0.511 MeV) or 2.00 MeV and the double-escape peak occurs at (E–1.02 MeV) or 1.49 MeV. The full energy peak represents those events for which there was a combination pair production and photoelectric effect in which all the energy was absorbed in the detector.

The extremely high resolution capabilities of the Ge(Li) detector arise from the small energy gap for this material which results in only about 2.9 eV, being required on the average for the production

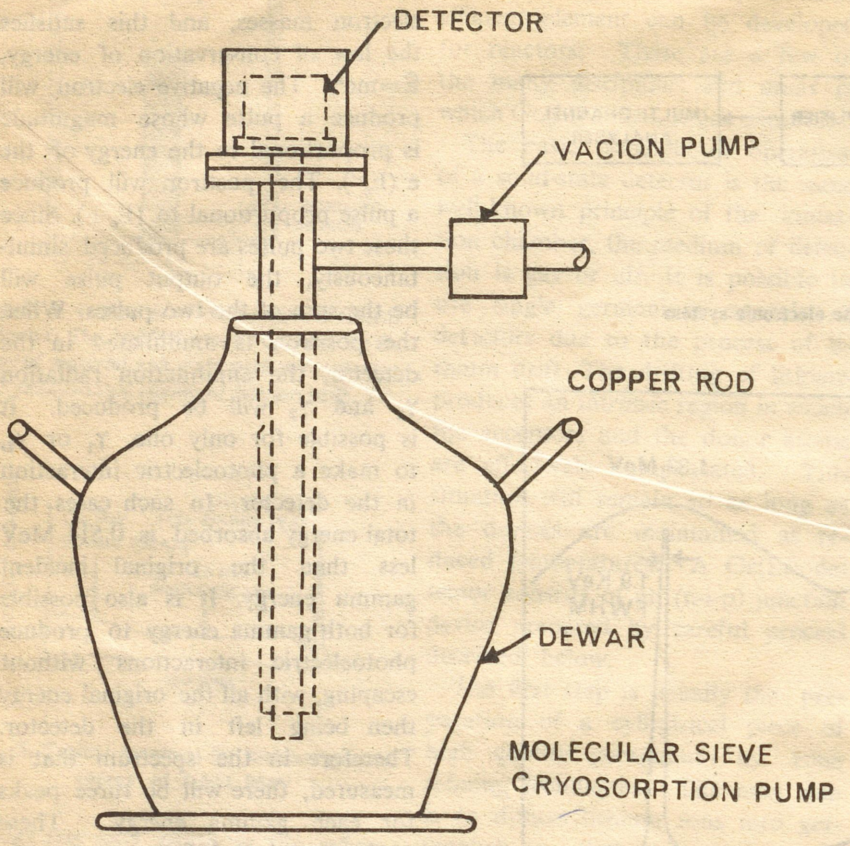

Fig. 6. Detector cryostat arrangement

of each electron-hole pair. The fact that energy is partitioned between the electron-hole creation and the phonon excitation process in a statistical but practically correlated manner, leads to fluctuation in the number of electron-hole pairs created for a given energy. This variance leads to a fundamental limitation of the minimum resolution that may be observed with an otherwise perfect detector. This leads to the best theoretical resolution of an ideal detector expressed as the full-width at half maximum (FWHM) of 0.50 keV at 100 keV, 1.50 keV at 1 MeV and 5.0 keV at 10 MeV.

A typical gamma ray spectrum of ^{60}Co observed with a Ge(Li) detector is shown in Fig. 3 with the Ge(Li), and the associated electronic set-up in Fig. 4. It consists of a full-energy peak corresponding to photoelectric absorption and a continuous Compton distribution. If the gamma ray energies are well above 1.02 MeV, one gets peaks corresponding to the escape of one or both annihilation radiation (0.5 MeV) produced after pair production.

The superior energy resolution obtainable with a Ge(Li) detector is illustrated in Fig. 5 which shows a comparison of ^{60}Co spectra of gamma rays taken with a $3'' \times 3''$ NaI(Tl) scintillation detector and an ORTEC Ge(Li) detector.

The resolution of the Ge(Li) detector is limited by the electronic noise contributed by the pre-amplifier and the amplifier of the spectrometer. The pre-amplifiers are carefully designed employing field effect transistors (FET). The contribution of noise by the pre-amplifier is described in terms of W_0, the FWHM in keV at zero capacitance (no detector). The function of the pre-amplifier is to transform the low-level current pulse from the detector to a voltage pulse, amplifying it suitably and provide a driver capable of transmitting the signal over sometimes longer lengths of coaxial cable to the input of the amplifier. Commercially this is accomplished with a charge sensitive pre-amplifier utilising an FET input stage. Although it has been well established that improvement up to 30—40 per cent in the pre-amplifier noise-figure can be obtained by cooling the FET to an optimum temperature.

The main amplifier is of equally sophisticated design and it has to have good gain-stability and good pulse-shaping quality. Further, the amplifier resolution should not deteriorate with higher counting rates. This is achieved by employing pole-zero cancellation and base-line restoration techniques in the amplifier circuit. To take advantage of the excellent energy resolution of the Ge(Li) detector, one uses a 4096 channel analyser and the main amplifier is followed by a biased amplifier which permits an expansion of any part of the gamma ray spectrum. In view of the excellent resolution of the Ge(Li) detector, the energy determination of the different gamma components is to be made very carefully. The peak position is carefully determined by knowing the peak profile. This analysis is performed by a computer program.

The linearity of the system is measured with an electronic pulser. Various gamma ray standards are used to check the response of the detector and to calibrate the spectrometer. Energy standards available over a wide range of gamma ray energies are used for this purpose. Once the energy of some gamma rays of a given spectrum are reliably

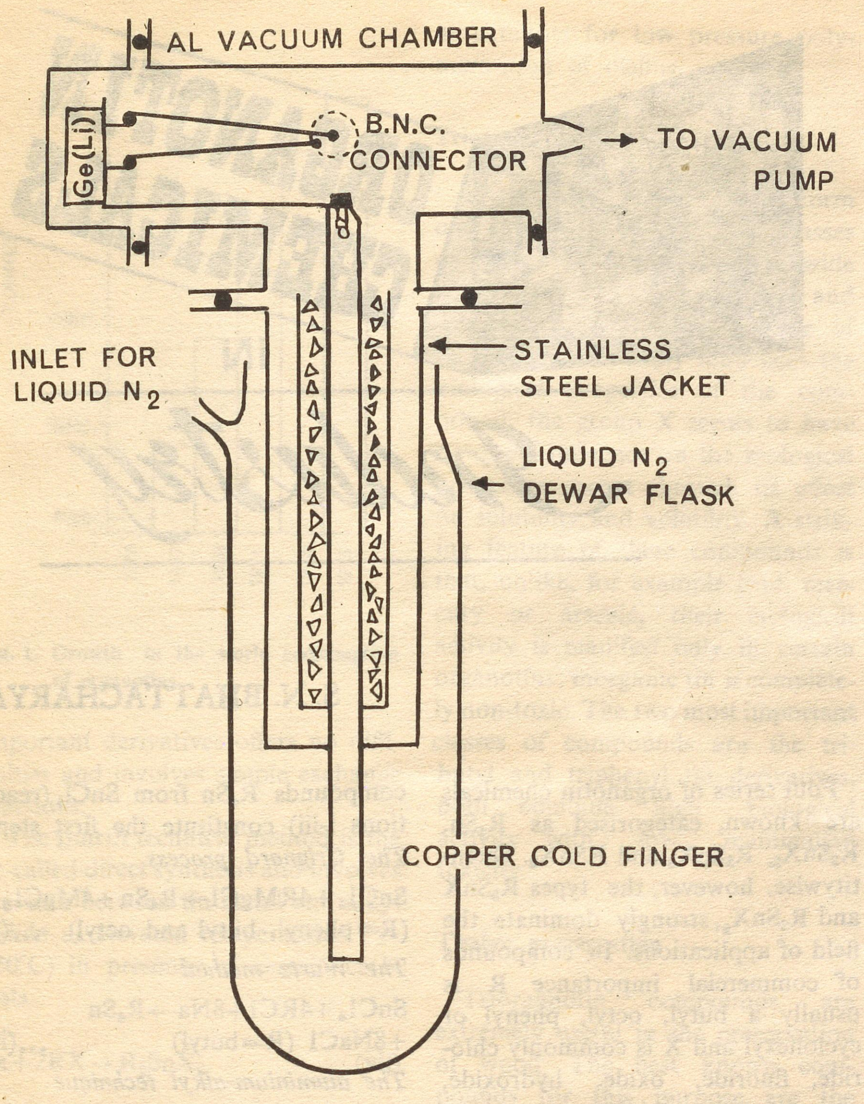

Fig. 7. Details of the Cryostat-Dewar assembly for use with a Ge (Li) detector

Fig. 7. The cryo-sorption pump material (molecular sieve/activated charcoal) is located between two concentric stainless steel tubes surrounding the copper cold-finger. The cryo-sorption pump creates adequate vacuum in the chamber for start up, after which the one litre per second vacuum ion pump takes over and maintains a high vacuum of the order of 10^{-6}. A control unit supplies the high voltage to the vacuum ion pump and also measures the current in the pump. The ion current is related to the vacuum in the detector chamber. The liquid nitrogen consumption of the system is approximately 10 litres per week. Constant attention should be paid to the shipment of the liquid nitrozen regularly so that the detector is protected from the accidental heating up to the room temperature.

determined, one can use these for internal calibration. The efficiency of the Ge(Li) detector must be determined before any quantitative analysis of the relative intensities of gamma rays is possible.

The use of high resolution Ge(Li) in a more complex arrangement usually involves coincidence arrangements with the other detectors. It requires the consideration of the characteristics of the detector in the time domain. Coincidence arrangements generally involve a further reduction of efficiency which may normally be expected to require the acceptance of high counting rates which almost inevitably produce degradation of the system's resolution.

The Ge(Li) detector has to be operated at 77°K (liquid nitrogen temperature) in order to keep the leakage current at a lowest possible value. The detector is usually kept in vacuum maintained by a zeolite sorption pump or an ion pump. The detector characteristics worsen if it is exposed to room temperature for a long time. A typical Ge(Li) detector-Cryostat system is shown in Fig. 6. The detector is housed in a small aluminium chamber with vacuum inside. The vacuum is maintained by a cryo-sorption pump and a vacuum ion pump as shown in

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ORGANOTIN CHEMICALS IN *Industry*

Tin is a versatile metal of many uses in a whole range of industries. Uses of its compounds, the organotins, extend into a vast number of fields

S. N. BHATTACHARYA

TIN, the element of atomic number 50, is a member of Group IV of the periodic table which also contains carbon, silicon, germanium and lead. It is a versatile metal of many uses in a whole range of industries. Its chemical compounds are no less important individually. Their uses extend into a vast number of totally different fields.

Tin is capable of forming organometallic compounds called "organotins". They contain 1 to 4 carbon atoms bonded directly to it. Organotins were for a long time only laboratory curiosities. Organic compounds of tin containing bivalent metal atom (Sn^{2+}) are not well-known. These species are highly reactive and unstable. Nowadays, the industrial application of organotin chemicals is so widespread and specialised that it is difficult to grasp the full potential of these compounds. It is considered worthwhile to summarise in this article the salient features of the commercially important organotin chemicals and to outline their scope in the major areas of use.

Four series of organotin chemicals are known, categorised as R_4Sn, R_3SnX_2, R_2SnX_3 and $RSnX_3$. Quantitywise, however, the types R_3SnX and R_2SnX_2, strongly dominate the field of applications. In compounds of commercial importance R is usually a butyl, octyl, phenyl or cyclohexyl and X is commonly chloride, fluoride, oxide, hydroxide, carboxylates or thiolate.

The histogram (Fig. 1) shows the rapid increase in the last decade in the consumption of organotins which is an indication of the advances made in the technology of their use. Their total commercial production is currently touching the limit of 25,000 tons at an estimated value of 450 million rupees. These figures are however expected to rise rapidly over the next few years.

Manufacturing processes

For the manufacture of commercially important organotins four different methods are presently used. In three of these the preparation of compounds R_4Sn from $SnCl_4$ (reactions i-iii) constitute the first step:

The Grignard process

$SnCl_4 + 4RMgCl \rightarrow R_4Sn + 4MgCl_2$
(R=phenyl, butyl and octyl) ...(i)

The Wurtz method

$SnCl_4 + 4RCl + 8Na \rightarrow R_4Sn + 8NaCl$ (R=butyl) ...(ii)

The aluminium-alkyl technique

$3SnCl_4 + 4R_3Al \rightarrow 3R_4Sn + 4AlCl_3$
(R=O ctye) ...(iii)

Relative ease and efficiency, with which an organic group can be redistributed among the tin atoms (reactions iv-vi), are the most unusual features of organotin chemistry and constitute an essential economic factor for the production of organotin chemicals in very high yields starting from tetraorganotins.

$3R_4Sn + SnCl_4 \rightarrow 4R_3SnCl$ ..(iv)
$R_4Sn + SnCl_4 \rightarrow 2R_2SnCl_2$ ..(v)
$R_4Sn + 3SnCl_4 \rightarrow 4RSnCl_3$ ..(vi)

The subsequent conversion of these chlorides into several industrially

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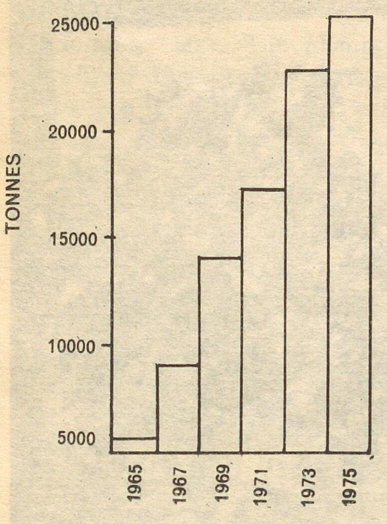

Fig. 1. Growth in the world consumption of organotins

important derivatives offers no difficulties and involves simple exchange reactions.

The fourth technical method is the so-called direct synthesis and involves reaction between tin metal and alkyl halide at elevated temperatures ($>$ 150°C) in presence of certain catalysts.

$$Sn+2RX \rightarrow R_2SnX_2 \qquad \text{(vii)}$$

Tetraorganotins (R_4Sn)

Although some of these compounds are used commercially as intermediates in the preparation of other organotin compounds, their industrial usage is presently not high. Tetrabutyltin has found commercial use as a corrosion inhibiting additive to lubricating oils of mineral hydrocarbon origin, which are normally corrosive towards bearing metal alloys. Since aryl groups attached to tin are readily removed by mineral acids such as HCl, this property makes them useful as scavengers of traces of such acids. Both tetrabutyl and tetraphenyltin are used in combination with $AlCl_3$ and certain transition metal chlorides as catalysts for low pressure polymerisation of olefins.

Triorganotin compounds (R_3SnX)

Triorganotin compounds form one of the most important classes of organotins in view of their wide commercial use as insecticides and weedicides. Whilst the nature of the group R strongly influences the biological properties of the compound, the group X seems to have no direct influence on the biological properties except through its effect on solubility and volatility. A striking feature of these compounds is that, unlike, for example lead, mercury or arsenic, their biological activity is manifest only in certain organotins; inorganic tin is completely non-toxic. The two most important classes of compounds are the tributyl and triphenyl tin derivatives, both combine high biological activity with low mammalian toxicity.

Timber preservation

Triorganotin compounds are extremely useful in the preservation of wood. The best known compounds for this purpose are the tributyl tin derivatives as they are highly active against both fungi and the insects which attack wood. Tributyltin oxide, also known as TBTO, is a clear, colourless liquid with little odour at the concentrations employed. It has low mammalian toxicity, is resistant to leaching and does not increase inflammability.

Some researches have been carried out to establish the mechanism of protective action of triorganotins and to determine the factors which influence their penetration into the wood. They are applied by dipping, spraying or by vacuum impregnation method using a suitable organic solvent system. The growing commercial importance of this use is reflected in the fact that in the U.K. alone there are over thirty formulations containing organotins commercially available for timber preservations. The National House-Builder Registration Council of England requires that all wooden window joinery be given a preservative treatment for which a one-minute dip in organic solvent containing 0.5 % TBTO is considered suitable. Some aqueous formulations are being developed which would reduce application costs and prevent fire hazards in wooden materials in confined spaces, e.g., timbers in mines, attics or basements.

Another related and interesting preservative developed in 1973 is based on a mixture of TBTO, and a quaternary ammonium compound. This solution has been used in eradicating and inhibiting the growth of algae, mosses, lichens and bacterial slime on buildings, monuments and pavements. Such treatments, though toxic to the foulant, nevertheless cause no damage to the stone either by corrosion or staining.

Marine antifouling paints

The hulls of boats which are in prolonged contact with water are susceptible to attachment by plant growth and adherence of marine organisms such as barnacles, molluscs (especially mussels and oysters), tube worms, hydroids and sponges. The latter can seriously interfere with the running efficiency of the vessel by causing hull friction increasing fuel consumption and decreasing maximum speed. Tributyltin derivatives, e.g.,oxide and fluoride, are finding increasing use in antifouling paints which protect hulls against fouling (Fig. 2). These compounds being colourless allow light pastel shades to be used in paints and give no corrosion problems even on aluminium hulls where paints containing certain other metals can cause galvanic corrosion.

The active lifetime of antifouling paints may be extended considerably if the organotin compound is incorporated into a polymeric network, e.g, in polytributyltin methacrylate or in a chloroprene rubber. The controlled release of the organotin toxicant into the water, ensuring that the toxin is leached in the correct but steady dosages from the rubber or polymer matrix, makes the antifouling coating an extremely effective one. The frequency and time spent in dry dock for cleaning vessels have been considerably reduced and a fouling-free period greater than two years has been achieved with these paints. The possibility of the period being extended to more years is under study.

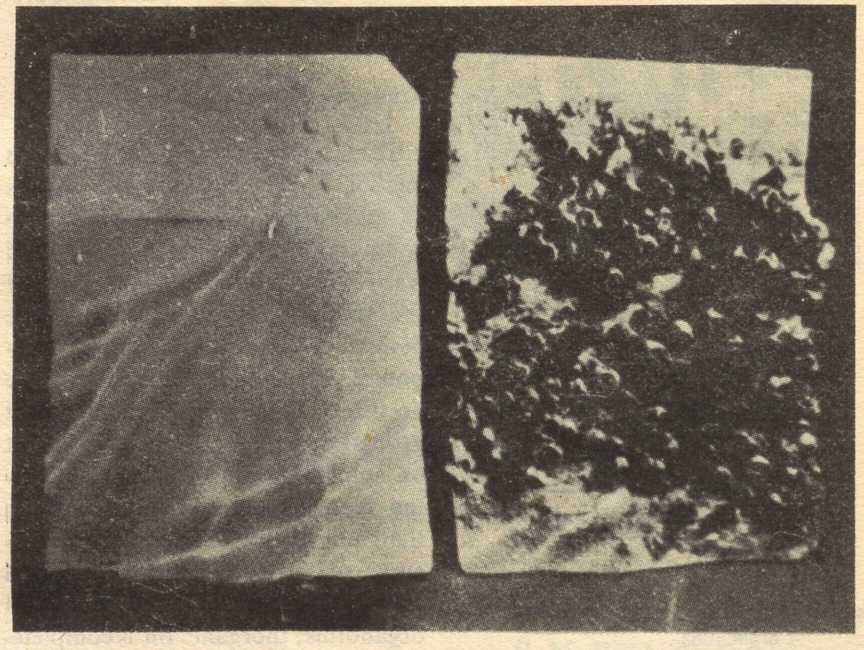

Fig. 2. Sea-water immersion tests. The panel on the left was protected with an organotin compound

Crop protection

Certain triorganotin compounds, e.g., triphenyltin hydroxide, acetate and fluoride are used in a number of agricultural formulations for controlling a variety of fungal growths which attack essential crops. Fungal diseases cause blight in potatoes, powdery mildew in sugarbeets and attack celeric, coffee, cocoa, groundnuts, bananas and rice. These fungicides are replacing those which have a tendency to inhibit growth of treated crops. Their importance in protecting foodstuffs, particularly in a developing country like India, has a vital role to play and needs serious and thorough trials by agricultural chemists.

Another important product, tricyclohexyltin hydroxide $(C_6H_{11})_3$ Sn OH, marketed by a chemical company of the U.S.A., is a miticide for protecting fruit orchards against spidermite. It is being used in Europe for protecting deciduous fruits and in the U.S.A. for citrus fruits. Residues of tin on sprayed apples and pears were found to be only 0.1 to 0.3 p.p.m. The residue existed only on the surface of the fruits and most of it could be removed by washing the fruits.

Studies of these chemicals on microbial activities in soil have shown that they have no significant impact on soil microorganisms.

Biocidal and related applications

Tributyl and triphenyltins are effective against many gram positive bacteria, including the antibiotic resistant staphylococci which are often the source of cross-infection in hospitals. Tests in which the compounds were incorporated into waxes and polishes, sprays for walls and ceilings, and in laundry washes demonstrated a considerable reduction of staphylococci. Tributyl in formulations are also important veterinary disinfectants and are used to protect textiles, socks and footwear against fungal and bacterial attack both in the industrial and the public health sectors. Small concentrations of these compounds prevent the promotion of slime and fungal growths in water and are used for this purpose in paper manufacturing mills and in closed circuit cooling water systems. Potentially important is the use of TBTO and of triphenyltin compounds in fighting the tropical Bilharzia disease. These compounds, at an extremely low (1 ppm) concentrations. are highly active against snails which act as intermediate hosts for the parasitic worms causing the disease. Tributyltin compounds are also effective as a rodent repellant and are used for impregnating cable sheaths to protect electric and telephone cables against gnawing.

Diorganotin compounds ($R_2 SnX_2$)

The properties of diorganotin compounds render them particularly useful in plastics industry, both as effective stabilisers in polyvinyl chlorine (PVC) and as catalysts in the production of polyurethane foams or in certain silicone elastomers.

Stabilisation of PVC

During the period 1962-1972 the world production of PVC resin went up from a mere half million tons to 7.5 million tons and is presently estimated at well over 10 million mark. The phenomenal growth of this plastic has resulted from its versatility as it can be made flexible or rigid, clear or opaque and is available in a multitude of forms and colours. However, a limitation is its tendency to degrade, accompanied by darkening of the PVC items on heating or on prolonged exposure to UV-or sun-light. This disadvantage turns out to be a credit to tin since diorganotins (e.g., dibutyl or dioctyltins) in as little as 0.5%= 2% in the polymer stabilise it and maintain its clarity and impact strength. This is at present the largest single application of organotin compounds. The dioctyltin compounds having almost negligible toxicity are fast replacing corresponding butyl derivatives in this field. Though admittedly certain diorganotin stabilisers are quite expensive compared to many other less effective and cheaper stabilisers, e.g., Ca/Zn or Ba/Cd, they do impart perfect colourlessness and transparency at a very small amount.

A good scope for organotin chemicals is in PVC bottles which posses lightness in weight, clarity and safety in use (Fig. 3). In the U. K. alone, about 12000 tons of PVC are used each year for this purpose and the demand is still growing. The building industry represents the next most important outlet for PVC. The applications here are continually broadening and include floorings, cladding for building exteriors, fencing, piping and clear sheet for roofing. In the U.S.A. the National Sanitation Foundation permitted the use of organotin stabilised PVC piping for potable water while in the U.K. the Building Regulations have recognised such PVC building materials as self-extinguishing.

Catalysts for polyurethane foams

Another important use of diorganotin chemicals, dibutyltin diacetates or dilaurate, is as catalysts in the production of polyurethane foams. Only a small amount (0.4%) of these chemicals is incorporated in these foams. The size of the polyurethane market (500,000 tons/year in the U.K.; and 1 million tons/year in the USA) makes this a sizeable outlet. Prior to the use of organotins these foams had to be produced in multistage processes which can now be prepared in one stage by mixing all the reactants together.

These organotins are also used in the production of rigid foams, e.g., structural furniture frames or seamless shining polyurethane floors. In making these floors a basecoat is applied by roller, spray or trowel to a specially prepared floor surface to be covered followed by two more such urethane glaze coats. Drying with tin catalysts is 1.5 to 3 hours to give hard wearing, durable, stain and scuffing resistant floors.

Catalysts for silicones

Certain vitally important silicones with tendency of free flowing liquids or viscous gums can under the influence of some dibutyltin catalysts lead to polymers which have elastomeric properties with added toughness and flexibility. These room temperature vulcanising (RTV) silicones are resistant to extremes of temperatures and to UV radiations and many chemicals.

Some of the wide ranging uses of these organotin-containing silicones involve use in dentistry, shoe making, art casting, electronics and mould making. Intricate details can be precisely reproduced and the flexibility of the material enables the mould to be readily detached from the original. This new process allows elaborately decorated art pieces to be moulded in one operation from vinyl or other plastic materials. The moulding and cooling cycle is only of 10-15 seconds. The mould takes many thousands impressions.

Other less known but equally important and interesting application of these diorganotin derivatives lies in the use of dibutyltindilaurate in the treatment of chickens for intestinal worm infections.

Monoorganotin compounds ($RSnX_3$)

This group of organotins has so far found only restricted applications. In Germany, monobutyltin sulphide is used in restricted quantities as a non-toxic stabiliser in the manufacture of certain specific types of PVC films. Some of them are used as water repellent agents. A recent (1974) biocidal screening experiment disclosed the first example of a mono-organotin compound, phenyl stannatrane, with an exceptionally high intrinsic fungicidal activity.

Environmental effect

The effects of organotins on both man and his environment have been examined. The main hazards in handling relate to potential contact with eyes and skin. In the long term, organotin chemicals however have the advantage of producing no harmful residues since they are eventually broken down to non-toxic inorganic tin compounds (probably stannic oxide) by atmospheric degradation. This is in contrast to the organolead and organomercury derivatives which occupy somewhat similar commercial importance. Though they are also converted into inorganic salts but still remain toxic. It is therefore not surprising that the U.S. Environmental Protection Agency (E.P.A.), which cited cases of nervous system disorders all over the world, made a sweeping move and put a ban from February 1976 on the use and production of virtually all organomercury pesticides used as bactericides or fungicides. Such a ban is bound to put further demand on organotin substitutes and the production of these chemicals is sure to go up.

Conclusion

From the tremendous increase in the production of organotin chemicals over the past few years, it is evident that they have become an indispensable commodity in modern technology. Moreover, all over the world, intensive research, both fundamental and applied, is going on in the field of organotin chemistry. From such efforts there is no doubt that the present applications will be extended and new ones uncovered. It is interesting to note that an International Tin Research Council was founded as early as1932 financed by major tin ore producers of the world (Bolivia, Indonesia, Malaysia, Nigeria, Thailand and Zaire) with the object of increasing the consumption of tin. The Council's Headquarters and Laboratories are the Tin Research Institute, England, with branches in several countries.

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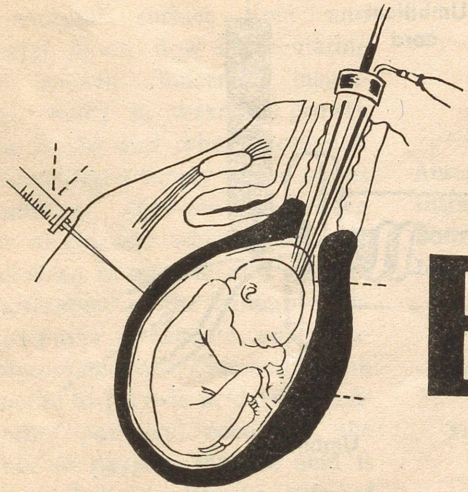
CORRIGENDUM

Ref. (i) Article **Beta-decay**, *SR* April, 1977 on page 237, Col. 3, line 40 for η/Ω *read* $\eta/2\pi$ and col. 3, line 41 for $\frac{1}{2}\ \eta/\Omega$ *read* $\frac{1}{2}\eta/\pi$

(ii) Article **Sodium-the uncommon metal from common salt**, April 1977 the author's name is R.K. Sapre and *not* R.S. Sapre as printed. Page 233, Col. 2, Para 1, Line 1 *read* reallowed *as* realloyed.



THE UNBORN BABIES NEED TO BE WATCHED

N. N. ROY CHOWDHURY
ARUP DAS

Current advances in biochemistry and technology have provided better methods for proper assessment of foetus and its environment

THE foetus, protected by the watery fluid and its 'jacket' of membranes, spends approximately 266 days in the uterus of its mother. Then, one day, painful, rhythmic, uterine contractions develop, leading to the expulsion of the conceptus from the genital tract of the mother. The new-born baby enters a new environment to accept the challenge of independent existence and ultimately adapts to this new milieu.

The placenta

During its intra-uterine life, the foetus solely depends on an organ of paramount importance, called the placenta, for its nutrition, respiration and other metabolic functions. The placenta is a disc-shaped structure, which at one surface is attached to the uterine wall of the mother. The foetal surface is attached at its centre with the umbilical cord running towards the umbilicus of the foetus. The cord contains two arteries and one vein embedded in Wharton's jelly (Fig. 1).

The placenta serves as an exchange station where, although the maternal and foetal blood streams do not directly intermingle, nutritional substances like glucose, amino acids, lipids, vitamins and minerals are transferred from the maternal side to the foetal one. Oxygen diffuses from maternal circulation to foetal circulation under the pressure gra-

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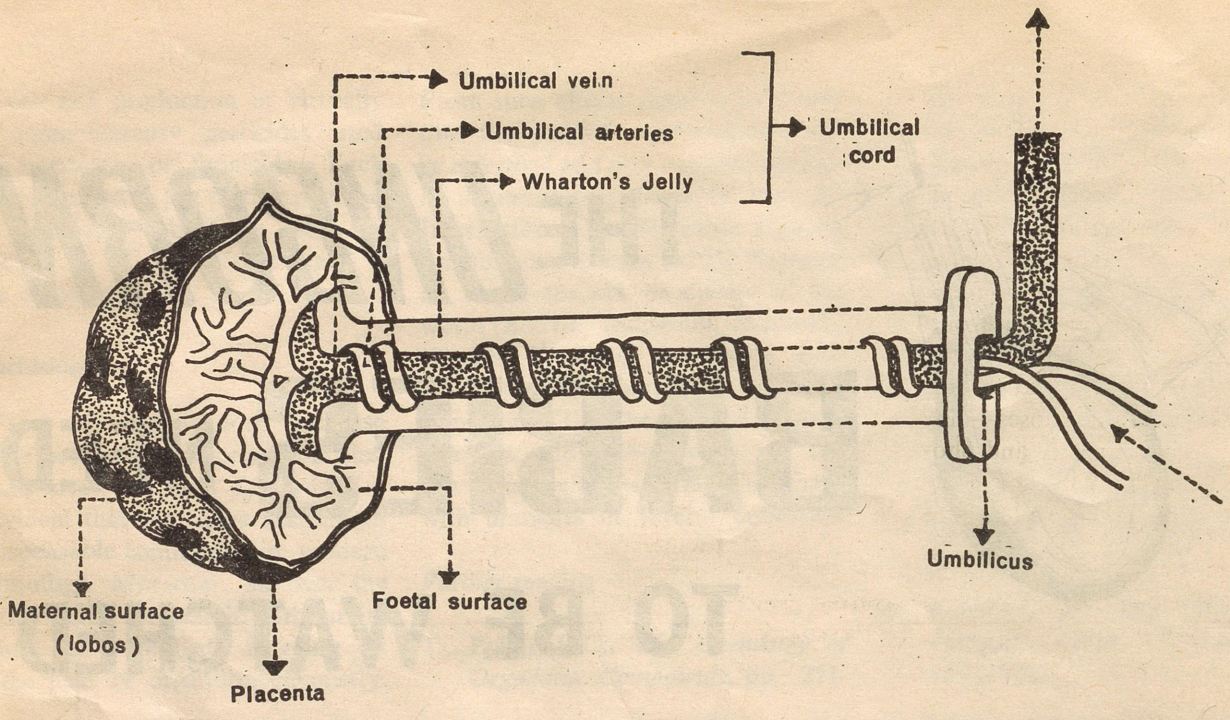


Fig. 1

dient of 35 mm of Hg, and carbon dioxide moves in the reverse direction under 7.5 mm of Hg. The placenta also behaves as an endocrine organ as it synthesizes hormones like oestrogens, progesterone, human chorionic gonadotrophin (HCG) and human placental lactogen (HPL).

As the well-being of the foetus is directly related to placental function, the foetal physiology is governed by the placental efficiency, which, in turn, is dependent on uterine blood flow and placental ultra-structure. To meet the increasing nutritional and oxygen demands of the foetus, the uterine arteries of the mother are provided with the following adaptations.

Firstly, the uterine artery is tortuous in its course so as to adapt itself to the enlargement of the uterus during pregnancy. Secondly, the branches are invaginated towards the centre of the uterine artery so that mainly the axial stream from the parent vessel is diverted through the branch (Fig. 2). As normally the blood cells run in an axial column separated from the vessel-wall by a peripheral plasmatic zone, each branch of the uterine artery receives blood rich in red blood corpuscles so as to supply increased amounts of oxygen to the foetus.

Thirdly, increased oestrogen level in maternal blood during pregnancy causes profound dilation of blood vessels. So, this results in enormous blood flow through the uterine artery. On the other hand, the foetal blood contains a special type of haemoglobin (Hb F), different from that of the adult. Hb F has a greater oxygen binding capacity than the adult haemoglobin.

Foetal distress

It has been observed that the babies with low birth weights have small placentas while the babies with high birth weights have big ones. Such a direct variation of the placental

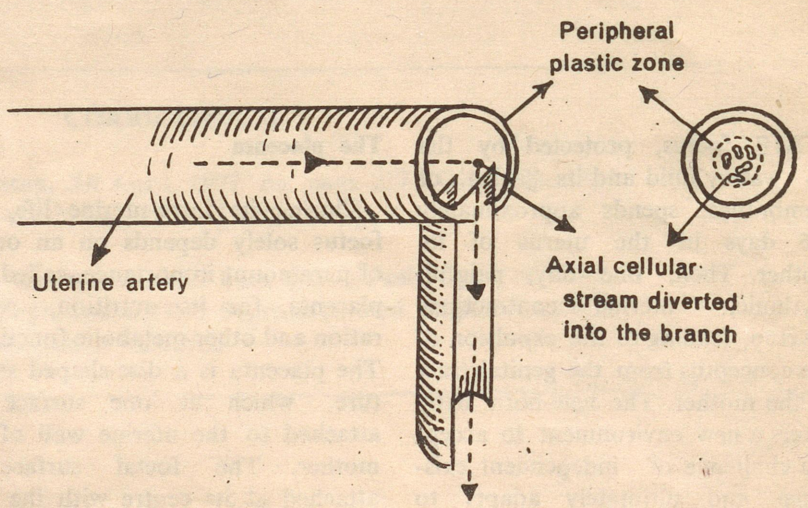


Fig. 2

weight with the weight of the new-born emphasizes the importance of placental surface area and placental blood flow in regulating foetal growth. Placental insufficiency results in retarded growth of the foetus and other anomalies.

When oxygen supply to the foetus is sufficient, glycogen is broken down to glucose, which is further metabolized to pyruvic acid through the formation of the trioses—dihydroxyacetone phosphate and phosphoglyceraldehyde. This conversion of glucose to pyruvic acid (Embden-Meyerhof pathway) occurs in the absence of oxygen. Pyruvic acid is now metabolized with the help of oxygen to carbon dioxide and water through the cirtric acid cycle. The net production per molecule of blood glucose, broken down aerobically via the Embden-Meyerhof pathway and citric acid cycle, is 38 molecules of energy-rich ATP (adenosine triphosphate). But in placental insufficiency, anaerobic breakdown of glucose via the Embden-Meyerhof pathway predominates the scene and pyruvic acid is converted into lactic acid, which gradually begins to accumulate in the blood. The net production per molecule of blood glucose, under anaerobic condition are 2 molecules of ATP. The acidosis at first reflexly increases the foetal heart rate, and the change in electrolyte balance is supposed to stimulate parasympathetic nerves causing increased motility of the gut and passage of 'meconium' (foetal bowel contents). The obstetrician calls this condition 'Foetal distress.' The causes of such 'distress' may be cord compression, spastic uterus, chronic hypertension, pre-eclampsia, etc.

One of the authors, N.N. Roy Chowdhury, carried out a study of 233 cases of foetal distress admitted in Eden Hospital, Department of Obstetrics and Gynaecology, Medical College, Calcutta, during the period from April, 1965 to March, 1967. An analysis of these cases showed that in 48.04 per cent cases antenatal factors (factors involved before birth) and in 37.32 per cent cases intranatal factors (factors related to labour) were responsible for foetal distress, while 12.01 per cent foetus suffered from the brunt of both (Table 1). Antenatal factors include the socio-economic status of the mother, the maternal age and parity, duration of pregnancy and incidence of pre-eclamptic toxaemia (high blood pressure, swelling of legs and/or albumin in urine) and essential hypertension in the mother.

Malnutrition, unhygienic environment, heavy physical work, worried

Table 1. Causative factors of foetal distress in relation to pregnancy and labour

Factors	*No. of cases*	*Incidence (per cent)*
Antenatal factors alone	112	48.04
Intranatal factors alone	87	37.32
Both antenatal and internatal factors	28	12.07
No pparent cause	6	2.57
Total	233	100.00

Table 2. Incidence of foetal distress in relation to socio-economic status

Social Class	*No. of cases*	*Incidence (per cent)*
Rich	12	5.14
Middle Class	72	30.88
Poor	149	63.98
Total	233	100.00

Table 3. Relationship of foetal distress with maternal age and parity

Maternal Age (in years)	*Primigravidae*	*Multiparae*	*Grande Multiparae*	*Total*
Below 20	53	—	—	53
20 to 29	91	22	12	125
30 and above	19	5	31	55
Total	163	27	43	233

Primigravidae: a women going through her first pregnancy
Multiparae: a woman who gave birth to more than 2, but than less than 5 viable babies
Grande Multiparae: a woman who gave birth to 5 or more viable babies

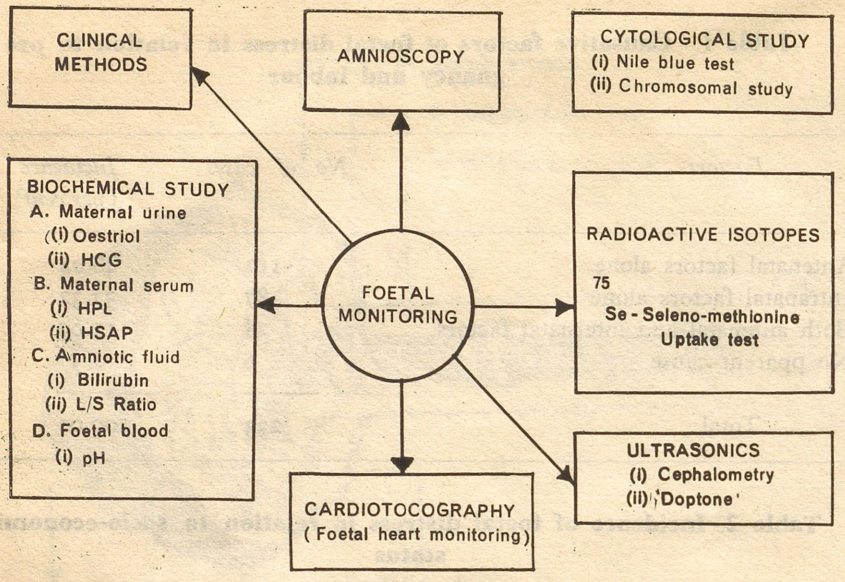


Fig. 3

and anxious state of mind in mothers of low income-group are possibly the causes of high incidence of foetal distress among the poor (Table 2). Babies of these mothers may be less able to withstand trauma during labour and delivery. The study also revealed that a woman going through her first pregnancy at a higher age (elderly primigravidae) is particularly prone to develop foetal distress, the incidence being 42.10 per cent even when there were no other associated factors (Table 3). The incidence of foetal distress at 43rd week of gestation is 4 times higher than at 40 weeks. Nearly 70% of the pre-eclamptic toxaemia cases suffered from foetal distress even when they were not complicated by any other factor. With increasing length of labour due to uterine inertia the incidence of foetal distress rises steadily.

From an analysis of the above causes of foetal distress, it may be postulated that vigilant supervision of the pregnant woman throughout pregnancy and labour, improvement of socio-economic status, avoidance of heavy physical work, worries and anxious state of mind in mothers can save many babies dying from premature death. Prevention of pre-eclamptic toxaemia and avoidance of post-maturity (pregnancy continuing for more than 42 weeks) are also essential for the same reason.

It must be remembered that the birth of a live-born baby is not necessarily an indication of good obstetrics. A baby subjected to diminised supply of oxygen during labour may

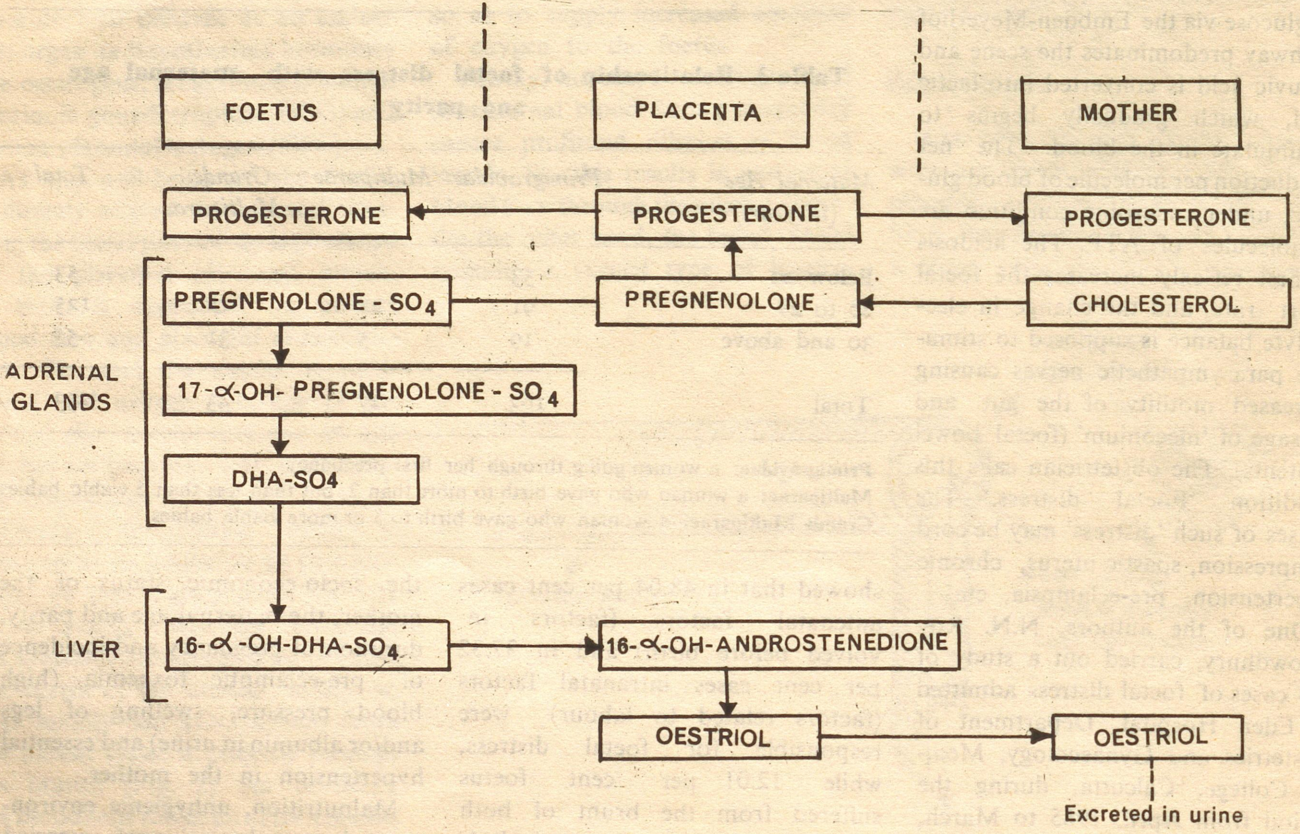


Fig. 4. Oestiol synthesis by "Foetoplacental units"

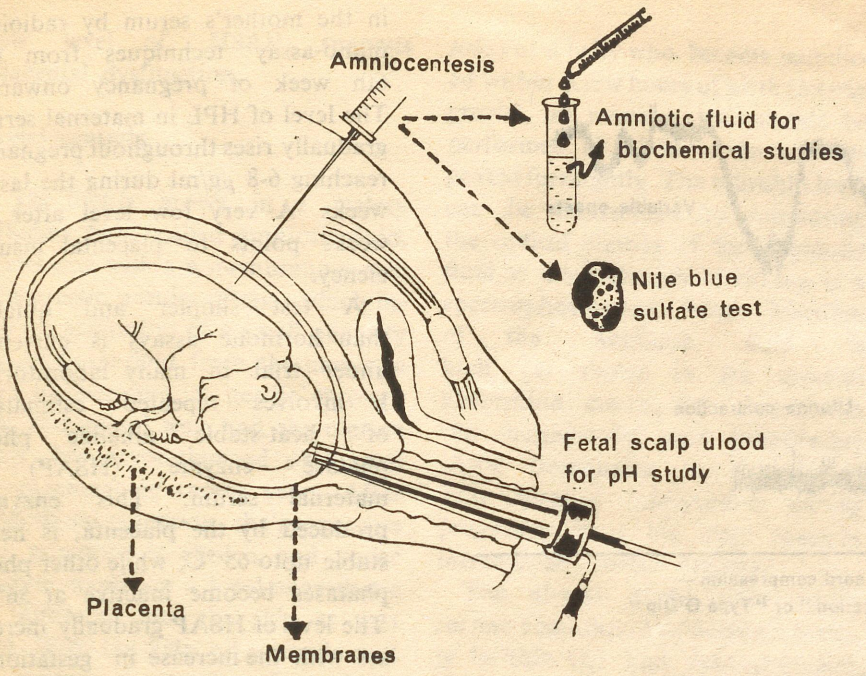


Fig. 5.

become mentally crippled afterwards. So foetal distress should be guarded against with the utmost precision.

Clinical diagnosis

The clinician still follows the traditional methods to diagnose foetal dist ess. Obviously this is a matter of personal choice. If the foetal heart sound, as heard with the stethoscope, shows any abnormality, specially a rate above 160 per minuite, and the vaginal examination shows passage of meconium-stained amniotic fluid, one may arrive at the diagnosis of foetal distress. Nowadays obstetrician however does not wholly rely on these traditional methods. Current advances in biochemistry and technology have provided him with better methods for proper assessment of the foetus and its environment. Such investigations can help him in monitoring the foetal growth and maturity and also in early recognition of 'at risk' foetuses so as to reduce the number of stillbirths and the first week deaths of babies by taking immediate measures (Fig. 3).

As the foetus is enclosed in a special environment, one has to study it without disturbing the pregnancy and without causing any harm to the foetus or the mother. A major breakthrough in this field came when A. Alberto Hodari and Lorna Thomas succeeded in 1969 in devising an intrauterine surgical technique for removal of foetal kidneys in dogs without any loss of amniotic fluid during operation. Now one can be optimistic that in the near future such operations will be performed on human foetuses also.

Endocrine and enzyme studies

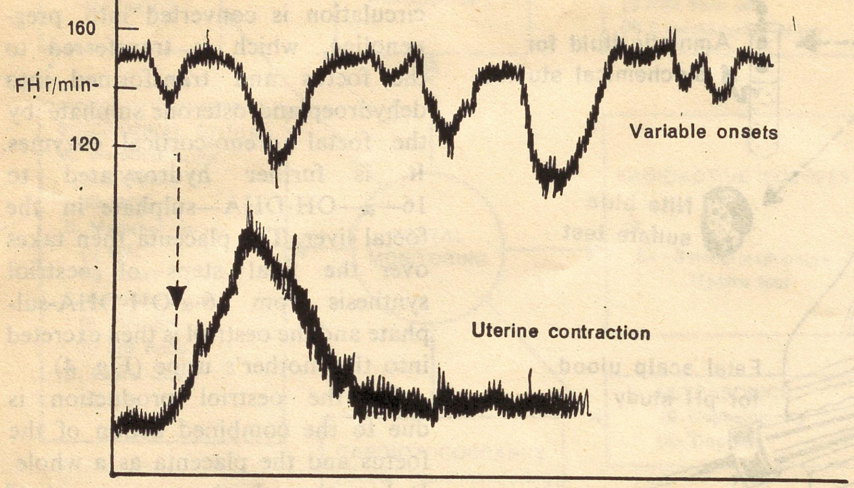
Currently the widely used method for assessment of placental function and the general well-being of the foetus is the estimation of oestriol level in the 24 hours urine specimens of the mother, at intervals, during late pregnancy. The oestriol is the metabolic end-product of the major secreted oestrogen hormone, oestradiol. The placenta lacks some of the enzymes necessary for the intermediate steps in the synthetic pathway of oestriol. The cholesterol reaching the placenta from maternal circulation is converted into pregnenoline, which is transferred to the foetus and transformed into dehydroepiandrosterone sulphate by the foetal adreno-cortical enzymes. It is further hydrozylated to 16—α—OH-DHA—sulphate in the foetal liver. The placenta then takes over the final steps of oestriol synthesis from 16-α-OH-DHA-sulphate and the oestriol is then excreted into the mother's urine (Fig. 4).

So, the oestriol production is due to the combined action of the foetus and the placenta as a whole. It has given birth to a concept of 'foeto-placental unit.' The quantitative measurement of urinary oestriol level of the mother is hence an indicator of functions of both, the foetus and the placenta. Repeated oestriol level screening is essential, otherwise a single isolated reading is of little help in diagnosing foetal distress. In cases of retarded intrauterine growth, haemorrhage from the genital tract after 28th week of pregnancy, but before the birth of baby, maternal hypertension, urinary oestriol levels are low and thus demand a prompt necessary treatment.

Human chorionic gonadotrophin (HGG) is a hormone of the placenta which can be detected in the mother's urine from the fifth week of pregnancy. The level of HCG rises to a peak (30,000 IU/24 hrs.) between the 8th and 12th weeks and then falls to a low level (5000 I U/24 hrs.) which is maintained throughout the rest of pregnancy. Repeated urinary HCG assay provides valuable information about the placenta, specially in cases of threatened abortion where a low level of urinary HCG against a specific gestational week indicates a bad prognosis.

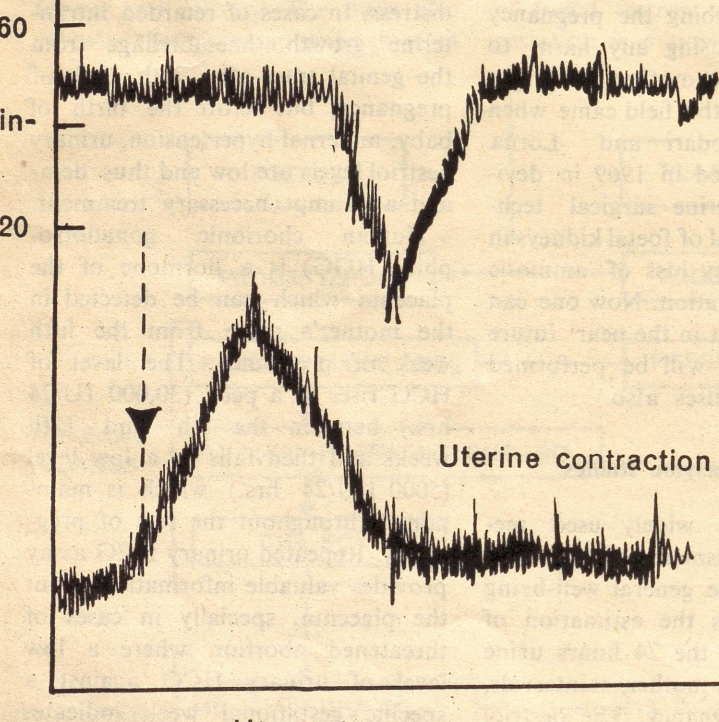
Another placental hormone, human chorionic somatomammotrophin (or human placental lactogen, HPL), can be demonstrated in the mother's serum by radioimmuno-assay techniques from the 6th week of pregnancy onwards. The level of HPL in maternal serum gradually rises throughout pregnancy reaching 6-8 $\mu g/ml$ during the last 4 weeks. A very low level after 35 weeks points to placental insufficiency.

A test simpler and quicker than hormone assays is currently under trial in many laboratories. It involves repeated estimation of heat-stable alkaline phosphatase enzyme (HSAP) in maternal serum. This enzyme, produced by the placenta, is heat-stable upto 65 °C, while other phosphatases become inactive at 56°C. The level of HSAP gradually increases with the increase in gestational period, and any abnormal high or

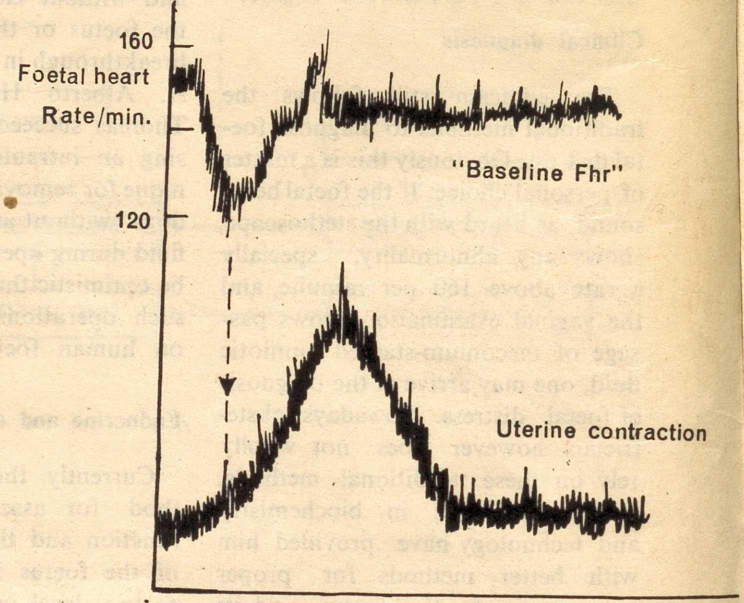


Umbilical cord compression—"Variable deceleration" or "Type O Dip"

Fig. 6. Foetal heart monitoring—graphic record



Utero-placental insufficiency
"Delayed deceleration" or "Type 2 Dip"



Head compression by uterus—"Early deceleration" or Type L Dip"

Fig. 7. Foetal heart monitoring-graphic records

low level of HSAP suggests placental dysfunction.

Amniocentesis

The foetus grows in a watery alkaline fluid, called amniotic fluid, contained within a membranous sac. Diagnostic amniocentesis, which involves aspiration of a small quantity of amniotic fluid from the amniotic sac by inserting a needle through the abdominal wall and the uterine wall, has revolutionized obstetrical management in recent years. After abdominal palpation, the proper site for puncture is chosen and under aseptic condition a local anaesthetic is infiltrated into the skin at that site. With the help of a needle and a syringe, a sample of amniotic fluid is drawn for biochemical, cytological and chromosomal studies (Fig. 5). This procedure usually does not cause any damage either to the foetus or to the mother, although rarely there lies the risk of damaging the placenta or the blood vessels running in the umbilical cord.

When the blood group of the mother is Rh-negative and that of the foetus is Rh-positive, it gives rise to a condition called Rhesus incompatibility. A few foetal red blood corpuscles 'leak' into the maternal circulation, specially at the time of placental separation. If the ABO blood groups of the mother and foetus are now such that there will be no cross reaction (ABO compatible), these foetal RBC will stimulate antibody production in the mother's blood. These antibodies on entry into another Rh-positive foetus during next pregnancy, will cause rupture of the foetal RBCs with the release of free haemoglobin in the blood. Excessive breakdown of haemoglobin in such cases will result in increased production of bilirubin which will ultimately stain the amniotic fluid. In Rh-negative women, who had a still birth or a pale oedamatous baby (*hydrops foetalis*) or a baby who became jaundiced within a few hours of birth (*icterus gravis*), the amniocentesis should be performed at 24-30 weeks and repeated fortnightly. The bilirubin level can be determined by measuring the optical density of the amniotic fluid at a wavelength of 450 $m\mu$ in a spectrophotometer. When bilirubin of the amniotic fluid is high (as shown in the spectral absorption curve), the obstetrician can immediately start intrauterine blood transfusion to the foetus. This surgical intervention during pregnancy is a big step towards intrauterine foetal surgery.

The alveoli of the foetal lungs secrete some liquid substances, mainly lecithin (L) and sphingomyelin (S) into the amniotic fluid. Normally after the birth, molecules of L, called surfactant, spread over the alveolar epithelium at the air-fluid interface and coalesce together during expiration, when the alveolar size decreases. And lecithin thus prevents the complete collapse of the alveoli by lowering their surface tension. With advancing weeks of gestation, amounts of L and S proportionately increase in the amniotic fluid. But at 35 weeks L/S ratio suddenly changes from 1:1 to 2:1, which indicates that lungs are functionally mature. The stress due to deficiency of oxygen results in acidosis and a fall in pH level of the foetal blood. At a pH of 7.0—7.2, the methyl transferase pathway for synthesis of lecithin is inhibited resulting in deficiency of the surface-active alveolar lecithin which causes Respiratory Distress Syndrome (RDS) in the newborn. So, if during late weeks of pregnancy the L/S ratio of the liquor sample is found to be less than 2:1, it indicates deficiency of lecithin and hence foetal lung immaturity. With L/S ratios of less than 1.5, the incidence of Respiratory Distress Syndrome has been found to be 100%.

The foetal skin cells shed into the amniotic fluid are stained by the nile blue sulphate test to detect foetal maturity; the test involves the use of 4 drops of the liquor and 4 drops of 0.1% of nile blue sulphate incubated at 37 C for 3 minutes. One drop of this mixture is examined microscopically, and the percentage of the orange-stained lipid containing squamous cells' is calculated. Normally, from 36 weeks onwards the number of the lipid cells increases, and a concentration of lipid cell more than 50% suggests that the foetus is mature.

Amniocentesis is employed in many centres for diagnosis of chromosomal anomalies in a child before birth and for sex determination of the foetus suspected for hereditary sex-linked diseases. Some of the 'inborn errors of metabolism' (due to enzyme deficiency) can be diagnosed *in utero* by assessing the specific enzyme activity in the amniotic fluid cells.

Amnioscopy

An amnioscope is a metallic tube with an illumination source and can be introduced into the cervical canal for visualizing the *liquor amnii* to detect presence of any meconium. Meconium staining of amniotic fluid as revealed by amnioscopy, suggests that the foetus is suffering from diminished supply of oxygen (foetal hypoxia). Meconium, added to the amniotic fluid, provides a good culture medium for bacteria like *Escherichia coli* and *Listeria monocytogenes* and exposes the foetus to infection. Amnioscopy can be carried out in five minutes and may guide the obstetrician whether the foetus should be delivered immediately or not.

Ultrasound

Among the sophisticated techniques used in obstetrics, one which has caused dramatic impact is the use of ultra sound. The sound waves beyond the normal range of audibility (with frequency more than 20,000 cycles per second) are called ultrasounds. They can be used (1) to measure the transverse diameter between the two lateral eminences of the foetal skull, called biparietal diameter (Cephalometry), (2) to locate the site of attachment of the placenta, (3) to diagnose foetal abnormality, and (4) to monitor the foetal heart activity (Doppler Flowmeter or DOPTONE).

In cephalometry, the ultrasonic beam, reflected back from the sides of the foetal skull, is graphically depicted on the cathode-ray screen. Repeated measurements of the biparietal diameter of the foetal skull will guide in assessing foetal growth and maturity. The 'DOPTONE' sends the ultrasonic beam towards the moving foetal heart. As the foetal heart surface alternately approaches and retreats from the mother's abdominal surface, the frequency of the reflected beam alters according to the Doppler principle. It can detect the foetal heart sound as early as in the 12th week of pregnancy. Any increase in the foetal heart rate (over 160 per minute) reflects the response of the foetus to a hypoxic condition. So far ultrasound for diagnostic purposes has been found to be without any risk, although in a very few cases chromosome breakages in the foetus have been reported.

Foetal heart monitoring

Recently, continuous foetal heart monitoring during labour is suggested to be one of the most important methods for detecting 'foetal distress'. This method is too expensive for our country and then the correct interpretation of the graphical records is also very difficult. The same instrument simultaneously records the foetal heart rate (FHR) together with the uterine contractile activity (tocograph). During normal labour, the baseline FHR between two uterine contractions is 120 to 160 per minute. In cases of head compression by uterus, the FHR decelerates just before each uterine contraction (early deceleration or Type I Dip). In uteroplacental insufficiency the FHR falls within 30 seconds of the onset of each contraction (delayed deceleration or Type 2 Dip). While the above cases show rhythmical alteration of the FHR in relation to the onset and duration of the uterine contractions, the FHR in cases of umbilical cord compression, decreases irregularly with variable onsets without a definite relationship with the contraction of theuterus (variable deceleration—Type O Dip). A prolonged variation of the FHR for more than 10 minutes positively suggests foetal hypoxia (Fig. 6).

Conclusion

Most of the methods mentioned above are not in practice in our country as they need highly sophisticated electronic equipment and laboratory facilities. Again, a single test is of limited help in assessing foetal distress and maturity. As, for example, R. M. Rome, S. C. Simmons, M. Bearne and D. Watson (Windor and Slough Obstetric Unit, Upton Hospital, Slough, Berkshire, UK) in 1976 have stressed more upon the importance of the combined use of L/S ratio, amniotic fluid creatinine concentration and nile blue sulfate test than on the use of single test of L/S ratio for an accurate assessment of foetal lung maturity. The maturational status of the lungs is now thought to be an important parameter of foetal maturity. It is because lungs are the most vital organs needed for adaptation to the extrauterine environment. The clinical findings and the biochemical information, supported by foetal heart monitoring and foetal scalp blood pH study, if available, should be analysed as a whole before coming to a positive conclusion about the well-being of the foetus. The estimation of foetal maturity will help obstetrician to establish the optimal time for delivery in "high-risk pregnancy" conditions.

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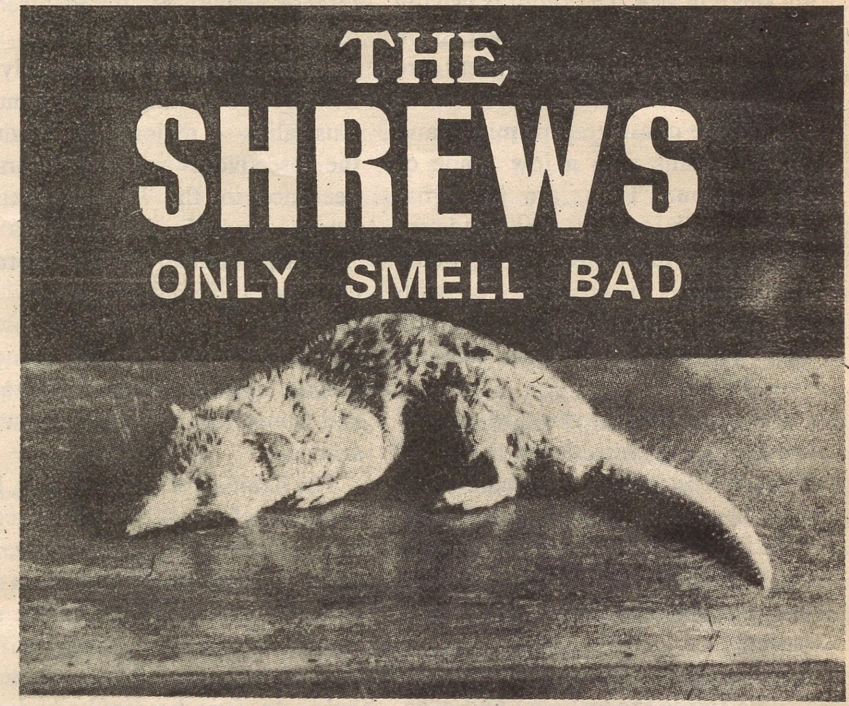

People react badly to shrews, because of their unpleasant body smell and likeness to rats in appearance. The truth is they are a helpful animal

ARUNA MOHAN

THE shrew or the 'chuchunder' has been the object of much legend and superstition. In the first century A. D., the presence of venom in shrew was established. Galen, the Greek doctor of Emperor Marcus Aurelius, had a belief that venom of the shrew could even kill a man. However, in those days people used to believe that shrews in the house would ward off evil spirits. The North American Eskimos always avoided shrews, for they had the feeling that crossing a shrew's trail brought bad luck.

The shrew is an insectivore. The insectivores are so named not because they necessarily eat insects, but because their teeth are most suitable for this activity. The shrews are the smallest mammals. They are common almost everywhere, though are seen rarely because of their small size and nocturnal habits. The shrew is one of the most primitive placental mammals and, is close to the stem from which man arose.

The shrews are small in size, have short legs and pointed nose. They look like mouse. They belong to the insectivorous family soricidae; which is divided into three sub-families: soricinae (the red toothed shrews), seutisoricinae (the armored shrews) and crocidurinae (white toothed shrews). These three sub-families have 24 genera and 200 species.

A shrew has numerous sharp teeth. It resembles in size and dentition to some of the earliest mammals whose fossils date back to 200 million years.

The shrews are of special interest for several reasons. They are smallest mammals and their metabolic rate is the highest of all animals in this group. The masked shrew is reported to breathe 850 times per minute and has a pulse rate of 800 beats. A poisonous substance in the saliva helps the shrew in the capture of mice and other preys. This poisonous substance is produced by submaxillary glands and is capable of killing a mouse.

The musk shrew (*Suncus murinus*) frequents our homes at night in search of insects like cockroaches and crickets on which they feed. It is commonly confused with the rat, but can be distinguished by its pointed snout and depressed ears. A strong musky odour is emitted by the animal due to the secretion of the musk glands.

The shrews also interest man because they resemble animals from which many mammalian groups have evolved. The ancestors of lemurs, apes, monkeys and man himself are believed to have been somewhat like shrews. The tree shrews are considered to be the most primitive of primates.

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Order insectivora: characters

The shrews, hedgehogs and moles belong to the order Insectivora. They are small in size. The snout is usually long and tapered. The feet have five toes with claws. The teeth are sharp and pointed.

They are considered primitive and are eutherians with a low grade of organization. They are nocturnal or burrowing in habit. The auditary region is unprotected by a bulla. The uterus is bicornuate, i.e., with two horns (uterus duplex). The brain is small without cerebral convolutions.

The insectivores may be considered as the nearest ally of the stock of small cretaceous mammals from which arose, by a process of divergent evolution, different types of present day mammals. It is true that they have become specialized in several respects :

(i) reduction of zygomatic arch in some forms (hedgehogs) and even its absence in others (shrews)

(ii) weak pelvic girdle

(iii) occasional absence of pubic symphysis e.g. shrews

(iv) the well known spines of hedgehogs

(v) modifications of the limbs and girdles for digging in the fossorial forms like moles.

(vi) secondary elongation of snout to form a long pointed muzzle as in moles and shrews etc.

However, they share many primitive features with the metatheria and the cretaceous mammals both in the skeleton and in the anatomy of their soft parts. The skull is elongated and tubular.

The insectivores are nocturnal save the tree shrews (Fam. Tupaiidae). They are diurnal.

Distribution

Barring Australia and polar regions, shrews are found throughout the world. In forests, as in other parts of world, shrews are the most orvacious of the insect-eating mammals. Day and night, all the year round, they have short periods of intense activity separated by longer rests.

The insectivores are widely distributed, but are not found in Australian region. Geologically, the insectivores made their first appearance in the lower Eocane of Europe and North America.

A large number of insectivores are cursorial (running), a few like the moles are fossorial (burrowing), myogale (South Europe) and potamogale (West Africa) are aquatic and some like the tree shrews are arboreal.

The habitats of shrews vary. Most species prefer cool and moist regions but others flourish in hot, dry deserts. Some like to live in cold climates, burrowing under the snow in winter. The shrews are small in size ranging in length from $1\frac{1}{2}$ inches to 5 inches in body length. That is why the temperature and water evaporation have much to do with their choice of home sites.

Habits

Habits of shrews also vary. Some hunt in water for their food; others on land. Some which are small in size raid beehives through the entrances made by bees.

All shrews move about in short, fast runs, constantly uttering squawks, squeaks, twitters, whispers, and trills. In China, the *Suncus* shrews are called money shrews because their chatter sounds like the clinking of coins. The white toothed shrew of Southern Europe and North Africa has a grey breast but its cry sounds like chirpings of robins. In Italy it is called the red-breasted shrew.

Shrews are an aggressive animal. Male shrews fight each other and the one which wins may then dine on the loser. Inspite of their aggressiveness, they are very sensitive and delicate. The heart beat of the frightened shrew can rise to 1,200 per minute. The shrews do not live long. The average life span of a shrew is less than one year.

The common european shrew (*Sorex araneus*)

It is also found in Europe and Asia. It has a long head and small eyes. The ears are very short and scarcely visible. The feet are 5-toed. The tail is 2 inches in length. The body length is $2\frac{3}{4}$ inches. The muzzle ends in a mobile snout with whiskers. The body is covered by blackish or grayish brown coat on top, reddish streakings on the flanks and yellowish white underneath. This shrew, though small in size, can attack a rat larger than itself. It is a good borrower and can also climb.

The old world water shrew (*Neomys fodiens*)

It is 4 inches long. Its tail and the feet are covered by swimming hairs which are three inches long. The tail serves as a keel when the animal swims. These shrews have a thin body, elongated muzzles and tiny ears which are hidden in the hair.

The water shrew is found in most parts of Europe. It feeds on small water animals, mollusks, crustaceans, insects, fish, frogs and small birds.

The water shrew spends day hours in a den made near the banks of the water course. The den will have one entrance by tunnel from the ground surface and another under water. The den is linked by grass and is thoroughly protected. In this den, the female gives birth to litters of six to eight, several times during the spring and summer months.

The black shrew (*Soriculus nigrescens*)

It is found at the heights of $2\frac{1}{2}$

miles in Sikkim and Nepal.. It is about $2\frac{3}{4}$ inches in length with a tail not more than an inch.

The genus *soriculus* consists of six species that live on the southern slopes of the Himalayas. These shrews are related to the northern and Pacific water shrews.

The armored shrews

The armored shrews of the sub-family scutisoricinae consist of a single genus, *Scutisorex* which has two species, *S. congicus* (the conge armored shrew) and *S. somereni* (the Uganda armored shrew). These shrews have complex and strong skeletons, with elaborate interlocking vertebrae. They can easily support the weight up to 160 pounds without much harmt o themselves.

The lesser white-toothed etruscan shrew (*Suncus etruscus*)

It is the smallest mammal on the earth. It is 2 to 3 inches long. It never weighs more than 1/14 ounces. It has a tiny, pink snout and thin red feet. It never digs dens. It lives in southern Europe, Asia and Africa.

The Indian musk shrews (*Suncus murinus*) (Fig. 1)

The musk shrew, *Suncus murinus*, belongs to the family Soricidae. This animal is widely distributed in south and south-east Asia. It is slightly smaller than the house rat. The snout is pointed and projects beyond the lower lip. Eyes are extremely small and weak. The snout, pinna, limbs and tail appear pink due to sparse distribution of hair in these regions. They are short legged mammals covered with a dense fur. A pair of scent glands are found on the flanks in both sexes. These glands produce the unpleasant odour so characteristic of the animal. The male is usually larger than the female. The root of the tail is swollen in the male, but constricted in the female.

The reproductive habits of the musk shrew have been studied under laboratory conditions. It is a non-seasonal breeder. The male and the female live apart, except at the time of breeding. The gestation period is about 30 days. The litter size is usually 1-4. The *Suncus* it weaned at 17 days and becomes sexually mature about two weeks later. There is post-partum oestrus and hence fertile mating takes place if the female has access to a male. Hence pregnant and concurrently lactating females are sometimes met with.

Food habits

They hunt feverishly for insects in the undergrowth of leaf litter beneath the conifers.

The musk shrew is a frequent visitor to the kitchen and is a domestic pest which thrives on kitchen waste and insects. However, unlike the rat, it causes very little damage to food materials. They are the little mammals with a voracious appetite. They loose heat quickly. So they need more food in relation to their body weight than larger animals do. They eat frequently and most of them consume upto three times their weight when food is plentiful. The shrews' regular diet is beetles, spiders and larvae, supplemented in winter by the pupae of insects which they dig out of the ground. In the laboratory, musk shrews (*Suncus Murinus*) were fed with live frogs, meat, rice and milk.

The shrews have a higher metabolic rate than any other mammal and are unable to survive more than ten hours without food. In general they live on insects and worms. They relish cockroaches and crickets.

Eonomic importance

The body of a shrew is covered with dense fur. The fur is used for making coats. A pair of scent glands is found in the musk shrew. These glands produce an unpleasant odour. The odour is emitted especially during mating or when the animal is disturbed or when it is subjected to pain, stress or fear. In nature this odour is believed to save them from being eaten by animals. They are however the prey of owls, storks and vipers. Since they feed on cockroaches, crickets and other insects, they help us in reducing the number of harmful insects.

We know that rats spread plague. Unlike rats, the shrew does not spread any infection or disease. The shrews do not cause much damage to the food material. Sometimes shrew feeds on pupae of insects after digging. Thus they help to increase fertility of the soil. The poisonous saliva of shrew can even kill a mouse.

Man takes interest in shrews for various reasons. Its saliva contains a venom. This venom is not as powerful as the venom of poisonous snakes but can cause a human victim much pain and discomfort. The shrews are most welcome on farms. They help in holding down insect and rodent population. Some species of shrews eat insects twice their own weight every day.

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SCIENCE SPECTRUM

Water outside earth's galaxy detected

ACCORDING to an announcement from the Max Planck Institute of Astronomy, the presence of water outside the earth's galaxy has been detected for the first time, indicating the possibility of life in outer space. The astronomers from the United States, France and West Germany found rotating molecules of water with the help of the 108-foot Effelsberg radio telescope, the largest portable radio telescope in the world. The Institute said that the water molecules had a density of one for every 10 cubic centimeters and were situated on the edge of nebula "IC-133", 2.2 million light years away, or about one trillion times further than the earth from the sun.

The discovery suggests the possibility that other solar systems may exist with the same physical conditions as ours with planets and stars also formed by the condensation of dust and gas with the same type of life span. It is expected that astronomers would look for water vapour in more galaxies.

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Metal rectifiers

THE direct current is now superseded by the alternating current in view of the latter's special advantages. The preponderance of A.C. over D.C., however, does not always hold, for in a number of applications such as electric traction systems, electrochemical processes, printing work, movie projectors, electronic instrumentation (radio and TV receivers) and so forth, D.C. is important. D.C. is preferable in some of these devices. and in others it cannot be substituted. As the supply from power stations is A.C. in three phases, D.C. operated appliances have to do the extra job of converting alternating current into direct current. And the device which accomplishes this task is called rectifier. Obviously, such a device must satisfy a basic condition—it must be endowed with the property of unilateral conduction. Since a multiplicity of devices fulfil this criterion, a wide variety of rectifiers are available. Notable are the vacuum type and gas-and vapour-filled diodes based on thermionic emission, the mercury arc pool-cathode rectifiers, the semiconductor junction rectifiers, the electrolytic rectifiers and the metal rectifier A.C. to D.C. (and D.C. to A.C.) conversion can also be conveniently achieved with the rotary convertors. Each rectifier has its own mode of operation, its own merits and demerits. which may be used depending on the situation at hand.

A simple category of rectifiers is represented by the Metal Rectifiers, also called Barrier layer rectifiers or cells, based on the principle that a barrier layer between some specific combinations of metallic substance—usually a conductor-semiconductor pair—resists the flow of current in one direction but is ineffective in the other direction. This means that the barrier layer presents an almost infinite resistance to current flow in the inverse portion of the cycle and almost zero resistance in the forward portion. The adverb 'almost' is used because there is no device which blocks or lets through current (in a particular direction) completely—no rectifier is perfect.

Our knowledge of the barrier layer is meagre. However, it must be noted that the contact between the pair of substances used is of such close nature that the work function of the metal is at least partly lowered; the free electrons of the metal can therefore easily diffuse into the other participant involved.

Copper oxide and selenium rectifiers

A metal rectifier, frequently used, is the copper-cuprous oxide recti-

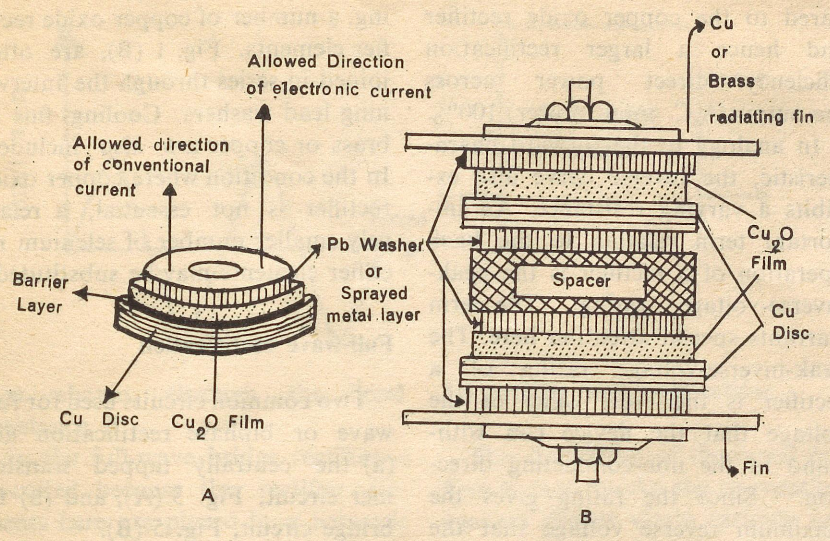

Fig. 1

fier, Fig. 1 (A). A rectifier element of this type is built up of a copper sheet or disc. One of the surfaces of the copper disc is subjected to a thermal treatment. This accumulates, by oxidation, a thin deposit in the form of a film on that surface. The deposit is composed of reddish brown cuprous oxide, Cu_2O. The oxide layer is scraped from a small portion where a wire is introduced (not shown in Figure) and connected to the copper disc. Further, as cuprous oxide has a high resistivity, the oxide layer is covered with a washer of soft lead. The primary objective of covering the oxide with a lead washer is to ensure a good electrical contact. A thin film of metal formed by spraying also suffices.

Another metal rectifier of wide commercial use is the selenium rectifier (Fig. 2). It is made up of a steel disc mantled on one side with a fine coating of selenium. The selenium coating is covered with a thin layer of a binary alloy in which the constituent metals are tin and cadmium.

The barrier layer in a rectifier of the first type is formed between the surface of the copper disc and oxide film. The obstruction layer is formed in a rectifier, of the second type between the selenium surface and the alloy film. In the copper oxide rectifier, the electrons can traverse the path copper$\rightarrow$oxide but are forbidden to diffuse the reverse way. Likewise, the electrons in the selenium rectifier can tread the path alloy$\rightarrow$steel but are not permitted to move from steel to alloy. The copper disc in the former rectifier and the alloy film in the latter may be considered as the counterparts of a diode's cathode. One must not however forget that, in either case, a fraction of electrons does not conform to the above rule.

A metal rectifier, of whatever type it may be, symbolized in a circuit-diagram by the notation is given in Fig. 3.

Static characteristic

A pertinent graph for a rectifier is its static characteristic. The static characteristic summarizes the relationship between the current in the rectifier and the terminal voltage. It correlates the instantaneous values of current and potential difference in a rectifier circuit containing no load resistance. Static characteristics for the copper oxide and selenium rectifiers are found to be identical in shape. Needless to say that, the characteristics will be non-linear. In Fig. 4 are sketched the volt-ampere curves, under zero load condition, for the forward and reverse operations of a typical metal rectifier. The curves resemble somewhat the familiar curves for semiconductor junction diodes. Useful information can be obtained from the volt-ampere graphs. Reciprocal of the gradient of the forward characteristic at a point gives the forward resistance of the rectifier at the point. It is clear from the figure that the tangents at different points of the forward curve have different inclinations to the voltage-axis. The forward resistance is a function of the applied voltage. As progressively increasing forward voltages are impressed across a metal rectifier, a slow increase in current is observed in the initial stages. If the process is continued, a stage comes when a small incre-

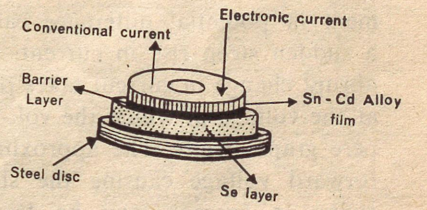

Fig. 2

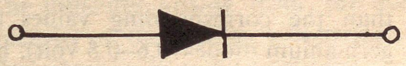

Fig. 3

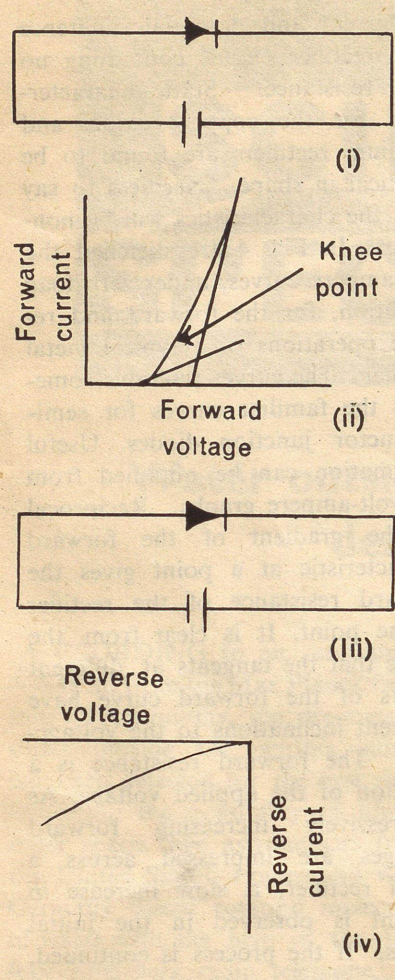

Fig. 4

ment in potential difference causes a sudden steep rise in current. The abrupt change in current takes place at the voltage at which the volt-ampere graph bends. The approximate forward voltage causing the sharp swing in current may be termed knee voltage if junction-diode nomenclature is extended to metal rectifiers. The sharp swing occurs in a copper oxide rectifier with forward voltages in the neighbourhood of 0.2 volt. The same happens in a selenium rectifier at a little higher voltage. The knee voltages are lower than the corresponding values for germanium diodes (0.6–0.8 volt), but are of the same order as the values for silicon diodes (0.2–0.3 volt). Though a selenium rectifier introduces a higher potential drop, it has a smaller forward resistance as compared to the copper oxide rectifier and hence a larger rectification efficiency—(direct power across the output/A.C. input power) 100%.

In analogy to the forward characteristic, the reverse curve also exhibits a varying resistance. An important term relating to the back operation of a rectifier is the peak-inverse-voltage rating. The term warrants special attention here. The peak-inverse-voltage rating of a rectifier is the crest value of the voltage that the device can withstand in the non-conducting direction. Since the rating gives the maximum reverse voltage that the rectifier can forbear, it serves as an index of the rectifier's tolerance in the inverse direction. Bearing this in mind, the rated peak-inverse-voltage of a rectifier should not be exceeded. A single element of copper oxide rectifier is readily damaged on applying a reverse potential difference above 10 volts. In contrast, the upper safety limit for the singly operated selenium rectifier falls around 30 volts. For comparison, the values for junction diodes lie in the range 25-30 volts. Because of the low peak-inverse-potential rating, a number of copper oxide rectifier elements, Fig. 1 (B), are often joined in series through the intervening lead washers. Cooling fins of brass or copper are also included. In the condition where copper oxide rectifier is not essential, a relatively smaller number of selenium rectifier elements may be substituted.

Full-wave rectification

Two common circuits used for full-wave or biphase rectification are: (a) the centrally tapped transformer circuit, Fig. 5 (A), and (b) the bridge circuit, Fig. 5 (B).

Now refer to Fig. 5 (A). During the half-cycle in which the potential difference polarities in the secondary winding of the transformer are as indicated, rectifier–1 admits of a current flow but rectifier–2 is non-conducting. In the second half, consequent to a reversal of the voltage polarity, the rectifiers interchange their roles—1 stops conduction and 2 starts conducting. The result is a pulsating unidirectional current—a mixture of D.C. with fluctuating component—in the direc-

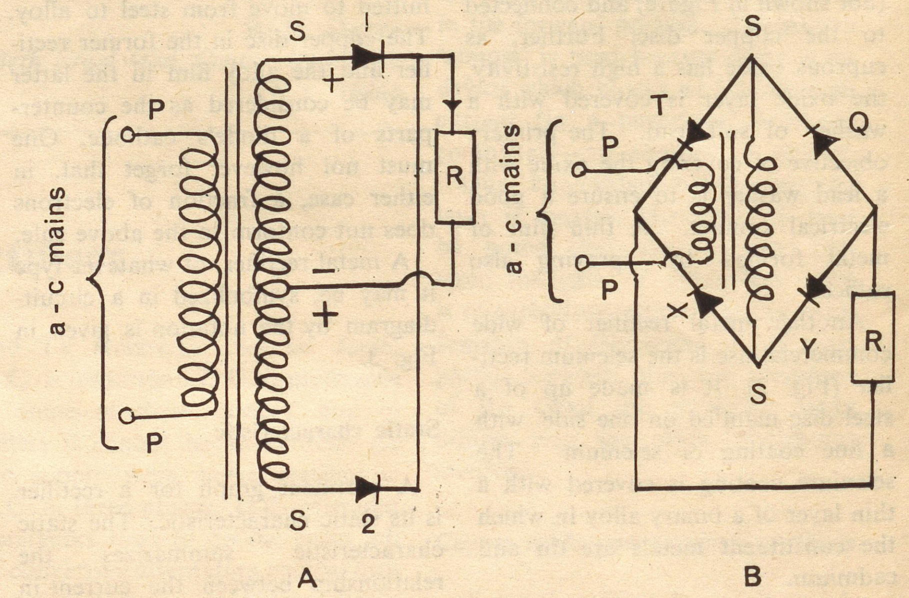

Fig. 5

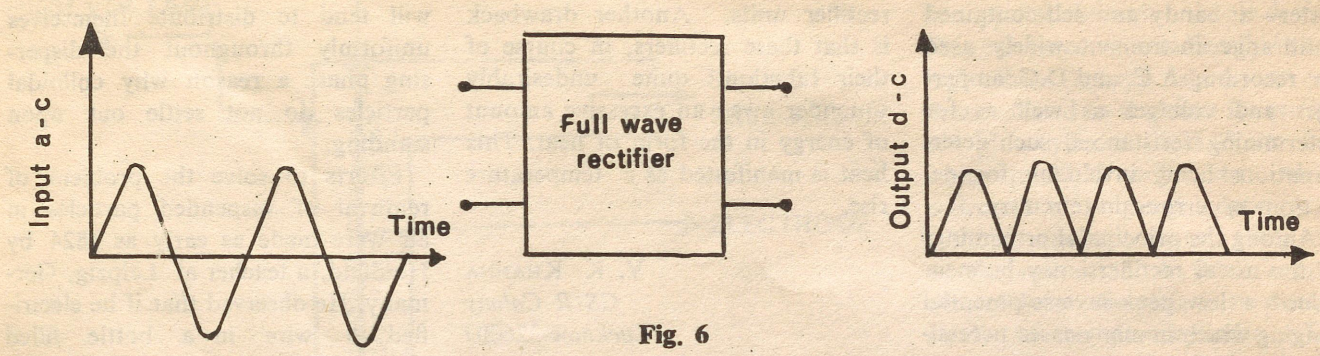

Fig. 6

tion shown, through the load resistance *R*.

In the full-wave bridge rectifier—so-called because the rectifier elements here are placed in a network like resistors in the arms of a Wheatstone bridge—current follows the path STRYS' in one half-period and the path S'XRQS in the subsequent half. Pulses of direct current are thus obtained.

In both cases, the waveforms of alternating current in the input and direct current in the output look like the chart in Fig. 6.

It is interesting to note that the centre-tapped transformer circuit gives a voltage output one-half the bridge circuit when energy from the same alternating-current supply is derived and the same transformer is used. This occurs because the centre-tapped transformer circuit makes use of (in each cycle) voltage across only half of the secondary coil.

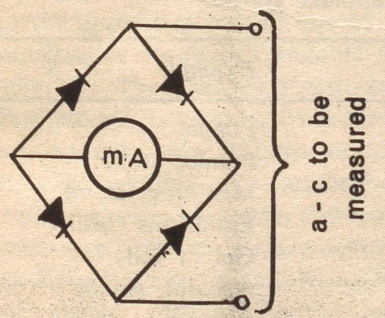

Fig. 7

Advantages and applications

The chief merit of the metal rectifiers is that, unlike the conventional vacuum diodes where cathode heating is indispensable, the metal rectifiers require no heating power. Moreover, in distinction to vacuum diodes, they can work in air so that an evacuated envelope is not necessary. The metal rectifiers have also an edge over the electrolytic rectifiers from the viewpoint of compactness. Other noteworthy advantages are installation without much difficulty and maintenance economy.

Often the circuit designer is confronted with a problem where a metal rectifier is the answer. The metal rectifiers, chiefly the copper oxide rectifier, is commonly used as a battery eliminator. The metal rectifiers may be designed to yield extraordinarily high current outputs at relatively low differences of potential and conversely incredibly low current outputs at comparatively large voltages. Such currents find use in specific technical applications, the former, for example, in industrial electrochemistry and the latter in X-ray work.

While in power applications, thermionic valves steal the limelight, the metal rectifiers (and the crystal rectifiers) are used in a number of electrical instruments. Important applications of the metal rectifiers are the rectifier A.C. meters—ammeters and voltmeters for A.C. measurements, designed on the principle that a sinusoidal alternating current of amplitude I_0 yields on conversion into direct current, a current of average value 0.637 I_0. Such an ammeter (Fig. 7) usually employs the bridge arrangement for full-wave rectification with copper oxide elements in the four arms and a D.C. Calibrations are milliammeter inserted diagonally, marked in root mean square values so that the ratio, root mean square value/average value equals 1.11. The rectifier voltmeter employs practically the same arrangement; a series resistance of a large magnitude is incorporated as usual.

Observations with these instruments may be vitiated due to several factors. First come the temperature effects on the rectifier itself. Secondly, these devices have resistance high enough to occasion an appreciable drop of potential difference. Thirdly, the signal fed may contain harmonic components so that a necessary presupposition is invalidated.

On the other hand, the rectifier A.C. meters extend to A.C. the advantages associated with D.C. moving coil instruments. In line with the common practice with moving coil devices, the range of A.C. rectifier instruments can also be enlarged. The difficulty arising from the nonlinearity of the rectifier's volt-ampere characteristic is easily overcome.

An arrangement of the above type is employed for A.C. measurements in (Avometer A—amperes, V—

volts, O—ohms), also called Multimeter—a handy and self-contained multirange instrument widely used for recording A.C. and D.C. amperages and voltages as well as for determining resistances, such determinations being invaluable for detection of errors in circuitry.

Among the principal shortcomings of the metal rectifiers may be mentioned a low peak-inverse-potential ranging which in many cases necessitates a series combination of several rectifier units. Another drawback is that these rectifiers, in course of their function, quite undesirably squander away an excessive amount of energy in the form of heat. This heat is manifested as a temperature rise.

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How smoke precipitates

WHEN a solute like sugar completely dissolves in a solvent like water, solute crystals are distributed at random throughout the water. This type of solution is called a true solution because the particles of solute are individual molecules that will not settle out of solution on standing. When sand is mixed with water, the particles of sand do not dissolve but settle down at the bottom of the container. This condition is called suspension. Sometimes aggregates of molecules of substances exist in colloidal state—an intermediate between a true solution and suspension in which the solute particle size is also usually an intermediate between particle size in solution and suspension. Hence it is the particle size which distinguishes the colloids.

	Particle Size
Suspensions	10^8 Å to 10^3 Å
Colloids	10^3 Å to 10^1 Å
Solutions	10^1 Å to 10^0 Å and still lesser in size

A colloidal system consists of colloidal particles, called the dispersed phase, which exist in the medium called dispersing phase. Colloidal system can be prepared in which either the dispersed phase or the dispersing phase is solid, liquid or gas. Accordingly, there are eight types of colloidal systems (Table 1).

Smoke is essentially a colloid in which solid particles are dispersed in air. The particles may be carbon, siliceous matter, particles of metals, oxides of metals and other kinds of matter associated with industries. Each particle of the dispersed phase in a colloidal system carries an electrical charge. The charges come from the selective adsorption of ions from the solution. Since, like charges repel each other, the colloidal particles in a given system will tend to distribute themselves uniformly throughout the dispersing phase a reason why colloidal particles do not settle out upon standing.

Efforts to solve the problem of removal of suspended particles in air were made as early as 1824 by Hohlfeld, a teacher at Leipzig, Germany. He observed that if he electrified a wire in a bottle filled with smoke, the smoke cleared rapidly and a deposit formed inside the bottle. In 1884 Sir Oliver Lodge in England rediscovered the phenomenon. A commercially unsuccessful attempt was made to utilize this effort in 1885.

If an electrically charged particle such as colloidal particle is placed in an electric field between two electrodes, it will tend to move towards the negative pole if charged positively and towards the positive pole if charged negatively. Charged particles in an electric field tend to migrate towards the weakest part of the field. If one electrode is a metal pipe and the other is a wire suspended axially in the pipe and potential is applied to both the electrodes, the field around the wire will be intense and the intensity will diminish radially towards the pipe. The colloidal particles when placed in such a situation are propelled rapidly through the gases by force of the electric field from strongest to the weakest part of the field,

Table 1. Types of colloidal system

Dispersed phase	*Dispersing phase*	*Example*
Gas	Liquid	Foams
Gas	Solid	Pumice stone
Liquid	Gas	Mist, fog, cloud
Liquid	Liquid	Emulsions (Milk)
Liquid	Solid	Gel or Jelly
Solid	Gas	Aerosol, smoke
Solid	Liquid	Paints
Solid	Solid	Coloured Gems and glasses

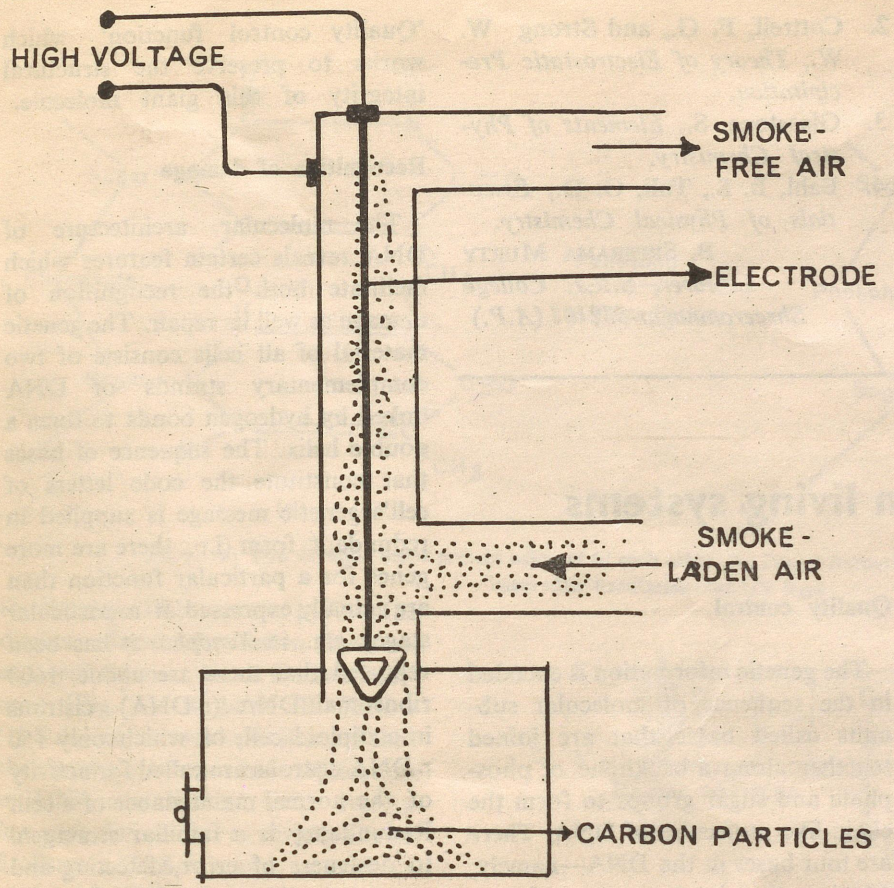

Fig 1. Cottrell smoke precipitator

from wire to the pipe surrounding it. This principle is utilized in Cottrell Electrostatic Precipitator which consists essentially of alternately charged high voltage plates through which the smoke passes before being let into the atmosphere. The dust particles, as they pass between the charged plates, acquire a static charge and are drawn to the oppositely charged plates where they are deposited. The cleaned gases pass to the upper header and out of the precipitator through a suitable flue (Fig. 1). The Cottrell Electrostatic Precipitator is valuable from economic point of view, because in addition to ridding the atmospheric pollution, valuable metals that would otherwise pass into air are collected as deposits on the plates. Recoveries of such metals have more than paid the cost of installation and upkeep in many industries in America and other countries. Other precipitators are also in operation using various types of electrodes and other devices.

In college laboratories of Shreeram Vidya Peeth, Shreeramnagar (A.P.), we tried to demonstrate the principle of Cottrell Precipitator through a simple device. This can be constructed easily in any high school science laboratory and demonstrated to students. It consists of a glass cylinder of 25.39 cm diameter and 91.43 cm height on which is wound a 24 gauge copper wire without gaps upto more than half of the cylinder. A thick copper wire of 2 mm diameter is suspended axially in the glass cylinder. The copper wire wound on the cylinder and the thick wire suspended act as the two electrodes (Fig. 2). As air is a poor conductor of electricity, an extremely high potential is to be applied. Under ordinary circumstances thousands of volts are required to breakdown the resistance. Hence the two terminals of electrodes are connected to an induction coil. Smoke by burning camphor or paper burnt in a separate container is allowed to pass into the chamber and the induction coil is switched on. Potential is applied to the electrodes and smoke is precipitated and deposited on the inner surface of the glass cylinder and clear fumes escape through a hole provided. It is also observed that as the potential applied increases, the precipitation is rapid and is achieved fully. This is

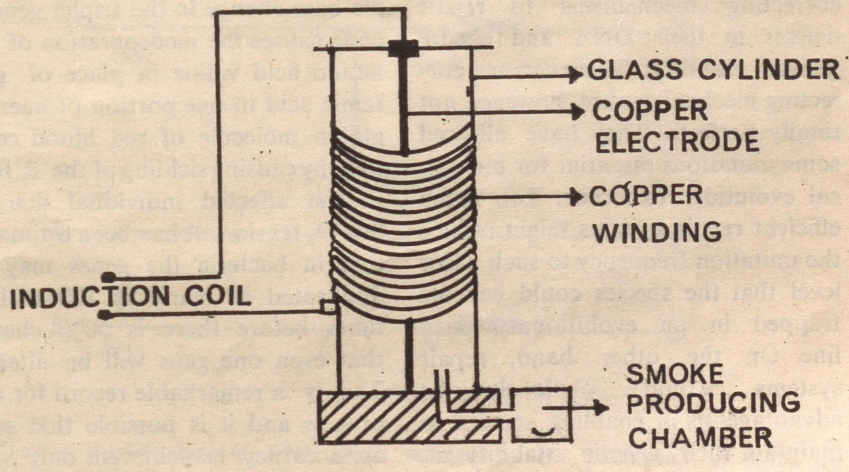

Fig 2. Smoke precipitator—Lab. model

a good demonstration of the principle involved in Cottrell's Electrostatic Precipitator.

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Repair of DNA in living systems

LIVING organisms are subjected to a variety of physical and chemical assaults from the environment. Some of them are natural like the UV rays from the sun, while others are several kinds of pollution caused by man. Exposure to hazards of these agents frequently damages DNA—the genetic material, which is so necessary for survival and perpetuation of living organisms. It is well-known that even a single base change in this giant DNA molecule can be lethal to the organism, yet the way these frequent damages are counter-balanced is really a remarkable feature of the living systems.

The living systems possess error correcting mechanisms to repair defects in their DNA and ensure genetic stability. These error correcting mechanisms are, however, not totally perfect. They have allowed some mutations essential for biological evolution to occur. Too much efficient repair systems might reduce the mutation frequency to such a low level that the species could become trapped in an evolutionary dead line. On the other hand, repair systems would obviously be advantageous in enabling species to maintain their genetic stability in an environment that caused mutations at a high rate.

Quality control

The genetic information is encoded in the sequence of molecular subunits called bases that are joined together along a backbone of phosphate and sugar groups to form the chain-like molecules of DNA. There are four bases in the DNA—namely, adenine, thymine, cytosine and guanine. Before a cell can divide and give rise to daughter cells, the DNA in the parent cell must be duplicated so that each daughter cell can be supplied with a complete set of genes. A single base alteration can result in a character different from the original one as in the case of sickle cell anaemia where a single base change in the triplet genetic code causes the incorporation of the amino acid valine in place of glutamic acid in one portion of haemoglobin molecule of red blood cells, thereby causing sickling of the R.B.C. in the affected individual due to low O_2 tension. It has been estimated that in bacteria the genes may be duplicated as many as 100 million times before there is 50% chance that even one gene will be altered. This is a remarkable record for any process and it is possible that such an accuracy is achieved only with the help of an error correcting mechanism. There is therefore a 'Quality control function' which works to preserve the structural integrity of this giant molecule.

Recognition of damage

The molecular architecture of DNA reveals certain features which facilitate both the recognition of damage as well its repair. The genetic material of all cells consists of two complementary strands of DNA linked by hydrogen bonds to form a double helix. The sequence of bases that constitute the code letters of cell's genetic message is supplied in redundant form (i.e., there are more genes for a particular function than are actually expressed at a particular stage), e.g., in *Xenophus* it has been reported that there are about 1600 ribosomal DNA (r-DNA) cistrons in a diploid cell, of which only 150 r-DNA cistrons are called for activity of the normal maintenance of a cell. Redundancy is a familiar stratagem to designers of error, detecting and error-correcting codes. The damaged portion of one of the strands of a DNA double helix can undergo repair by using the information in the complementary strand. The undamaged strand serves as a template for the reconstruction of damaged segment in the complemenatry strand.

Repair on exposure to light (Photoreactivation)

The repair system operates in different ways in different organisms. Actinomycetes subjected to a heavy dose of UV radiation, when subsequently exposed to an intense source of visible light, survived. Albert Kelner (1948, U.S.A.) explained the mode of UV action and the subsequent repair of damage in the following way.

The irradiation with UV resulted in the formation of two unwanted chemical bonds between pyrimidine bases adjacent to each other on one strand of the DNA molecule. Of

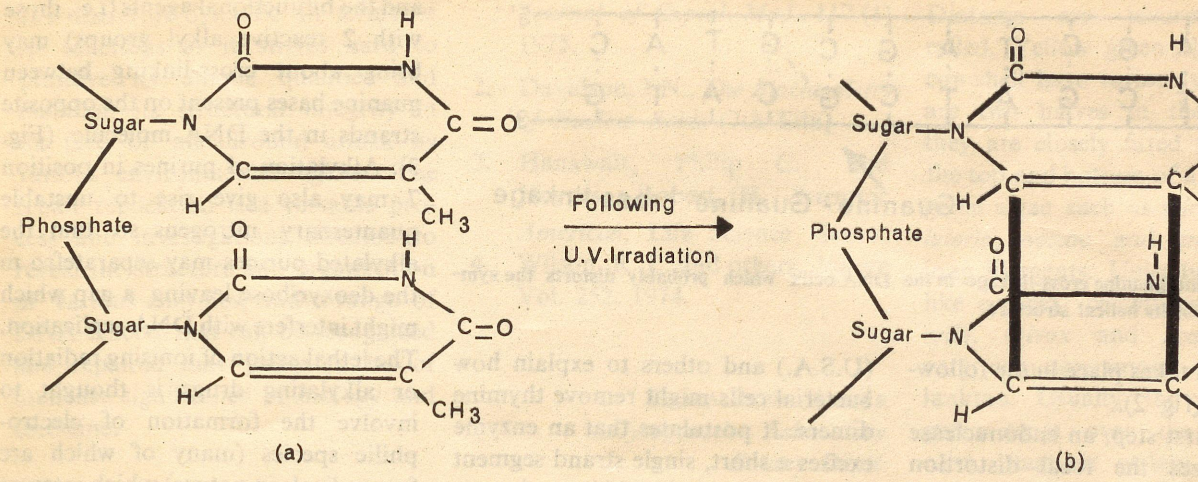

Fig 1. (a) Two thymine bases present adjacent to each other, (b) Dimer formation between adjacent thymine bases after irradiation with UV light

the three possible types of pyrimidine dimers, dimer formation between adjacent thymine bases is most common (Fig. 1). Richard B. Setlow (U.S.A.) and coworkers showed that the dimers block normal replication of DNA and bacteria with even a few such defects fail to divide. Claud S. Rupert (U.S.A.) and coworkers explained that exposure to visible light results in the activation of an enzyme which selectively binds to DNA irradiated with UV and facilitates the cleavage of pyrimidine dimers to restore the original DNA configuration. This process is called photoreactivation.

Repair without light (dark reactivation)

Yet another repair system which facilitates repair of damage to DNA is dark reactivation, so called because light has no role to play in the repair process. E. Witkin (1946) isolated a strain of the bacteria, *Escherichia coli* (B/r strain), which is particularly resistant to radiation. There are certain strains which however are sensitive to radiation (Bs-1 strain). It has been suggested that the radiation-sensitive bacteria lack one or more enzymes needed for repair of radiation-damaged DNA. It is probable that dark

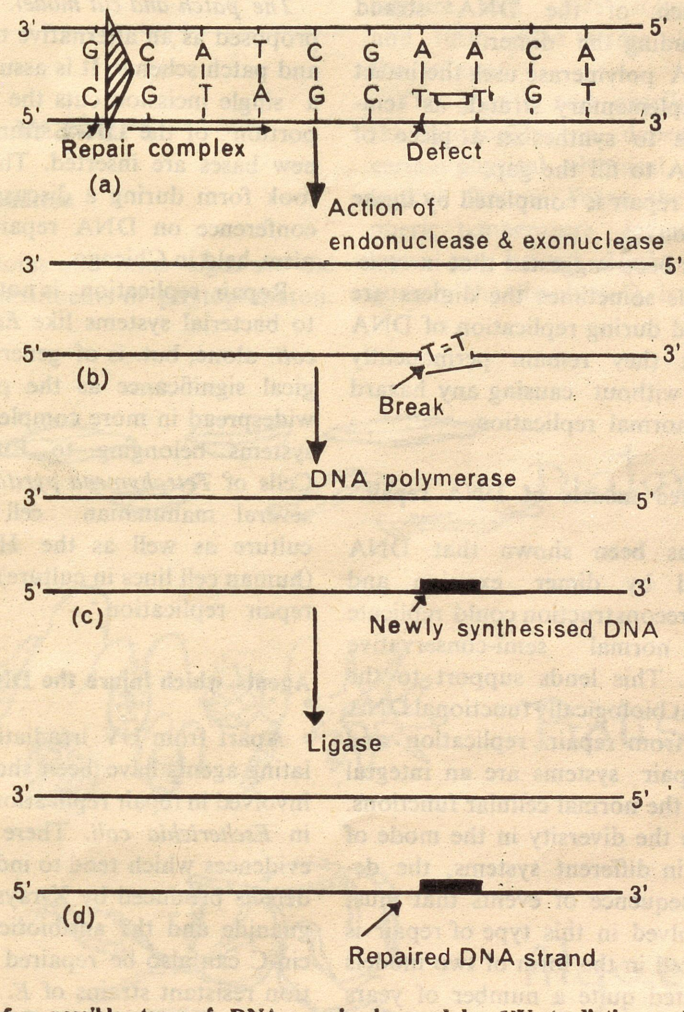

Fig. 2. The four possible stages of DNA repair demaged by UV tradiation, (a) & (b) Excission of dimer by sequential action of the repair complex, (c) Insertion of new complementary bases in the presence of DNA polymerase, (b) Final joining effected by polynucleotide ligase

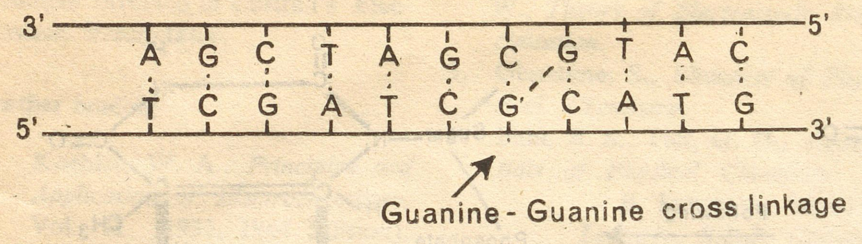

Fig 3. A guanine-guanine cross-linkage in the DNA helix which probably distorts the symmetory of its helical structure

reactivation takes place in the following way : (fig 2).

(1) In the first step, an endonuclease recognizes the local distortion so as to introduce a nick on the 5 side of dimer.

(2) A second enzyme excises a short stretch of the DNA strand including the dimer.

(3) DNA polymerase uses the intact complementary strand as template to synthesize a piece of DNA to fill the gap.

(4) The repair is completed by ligase action.

It has been suggested that in resistant cells sometimes the dimers are bypassed during replication of DNA so that they remain permanently present without causing any hazard in the normal replication.

Postulated models of DNA repair

It has been shown that DNA repaired by dimer excision and strand reconstruction could replicate in the normal semi-conservative fashion. This lends support to the idea that biologically functional DNA results from repair replication and that repair systems are an integral part of the normal cellular functions. Despite the diversity in the mode of repair in different systems, the detailed sequence of events that must be involved in this type of repair is visualized in the form of two models postulated quite a number of years ago.

The cut and patch model first proposed by Richard Setlow (U.S.A.) and others to explain how bacterial cells might remove thymine dimers. It postulates that an enzyme excises a short, single strand segment of the damaged DNA and new bases are inserted according to the rules of base pairing.

The patch and cut model. This was proposed as an alternative to the cut and patch scheme. It is assumed that a single incission cuts the defective portion of the DNA strand as the new bases are inserted. This model took form during a discussion at a conference on DNA repair mechanism held in Chicago.

Repair replication is not confined to bacterial systems like *Escherichia coli* alone, but is of general biological significance as the process is widespread in more complex cellular systems belonging to Eukaryotes. Cells of *Tetrahymena pyriformis* and several mammalian cell lines in culture as well as the Hela cells (human cell lines in culture) perform repair replication.

Agents which injure the DNA

Apart from UV irradiation, alkylating agents have been shown to be involved in repair replication of DNA in *Escherichia coli.* There are also evidences which tend to indicate that defects produced by X-rays, nitrosoguanide and the antibiotic mitomycin-C can also be repaired in radiation resistant strains of *E. coli.* The biological action of alkylating agents is a complex one. They are known to react with the purine bases, particularly guanines at the N-7 atom, and the bifunctional agents (i.e., those with 2 reactive alkyl groups) may bring about cross-linking between guanine bases present on the opposite strands in the DNA molecule. (Fig. 3). Alkylation of purines in position 7 may also give rise to unstable quanternary nitrogens so that the alkylated purines may separatefro m the deoxyribose leaving a gap which might interfere with DNA replication. The lethal action of ionising radiation or alkylating drugs is thought to involve the formation of electrophilic species (many of which are free radicals in nature) which interact with essential molecules as nucleic acid. The protective effect of certain nucleophilic compounds like cysteamine has been attributed to its ability to scavenge these species to prevent their reaction or to reduce chemically the free radical lesion thereby resulting in its repair (R.L. Wilson and others, 1974, U.K.).

Pathological conditions

Repair replication of DNA has been found to be defective in certain pathological conditions. The mechanism of repair synthesis is defective in the skin fibroblasts of patients suffering from the condition known as *Xeroderma pigmentosum* (Akiba, H. ; Kato, T. and others, Japan, 1975).

Poon, O'Brien & Parker (1974) have presented a very interesting case in their studies on DNA repair by fibroblasts from a patient with Fanconi's anaemia. Fibroblasts from such patients were found to be defective in the excision of DNA lesions. This probably is the result of a deficiency in an exonuclease function which removes the damaged strand of DNA after the endolytic scission has been made.

It is evident that DNA molecule not only contains a series of blueprints but also a coordinated programme of controlling its execution.

It is therefore dynamic in terms of its functions as it strives hard to preserve its unique qualities and maintain its structural integrity in the face of an allround attack by various environmental agents. The repair replication is a versatile process and investigations directed to reveal the structure and organisation of various enzymes, and a range of DNA defects that can be recognized and repaired may prove to be of immense significance in biology and medicine.

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Plankton in fresh waters

PLANKTON is a collective term coined by Hensen (1887) for the minute floating life in all types of aquatic systems such as pools, ponds, lakes, rivers, etc. It includes both plant and animal communities, and is referred to as phytoplankton and zooplankton respectively. Generally the planktonic organisms are found floating at the surface layers of water. However, they slowly descend vertically to the lower levels of water and then ascend to surface again. These two-way vertical movements are known as 'diurnal migrations' of plankton.

Limnology is the study of fresh water ecosystem. Plankton study is an important aspect of limnology. The abundance of plankton in an aquatic system is an index of high biological productivity (i.e., the rate of photosynthesis in which solar energy is utilised to convert CO_2, H_2O and nitrogen compounds into energy locked carbohydrates, proteins and fats). Plankton being a productive base provides food to the higher aquatic animals like fish and indirectly to man.

Phytoplankton

Diatoms and other algae are the main constituents of phytoplankton. Diatoms are invariably single-celled. Yellow green algae with silicon shell have various shapes. There are two halves in the shell, and they are closely fitted together like the top and bottom of a capsule. The green algae such as *spirogyra*, *oscillatoria*, *nostoc* and *anabaena* have long filaments. Unicellular protists like *euglena*, *chlamydomonas*, *chlorella*, *volvox* and *pediastrum* are very common among the phytoplankton. Usually the algae form green scum over the surface of calm, stagnant waters. The chlorophyll present in the cells of diatoms and algae serves for photosynthesis. Phytoplankton capture and store solar energy and form good source of food to the animals.

The growth and distribution of the phytoplankton depend upon certain physical, chemical and biological factors. When the atmospheric temperature increases, the water gets heated slowly. Consequently the dissolved O_2 is depleted

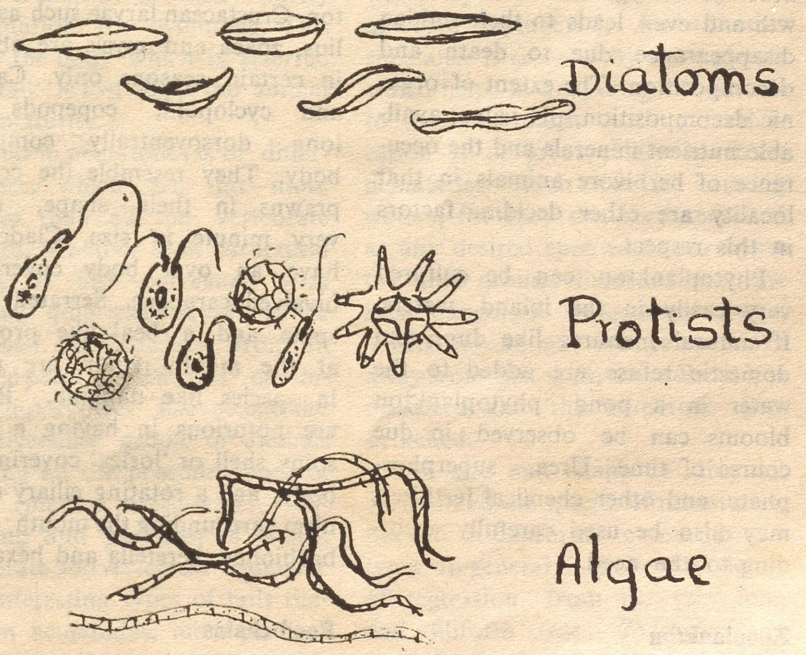

Fig 1. Phytoplankton

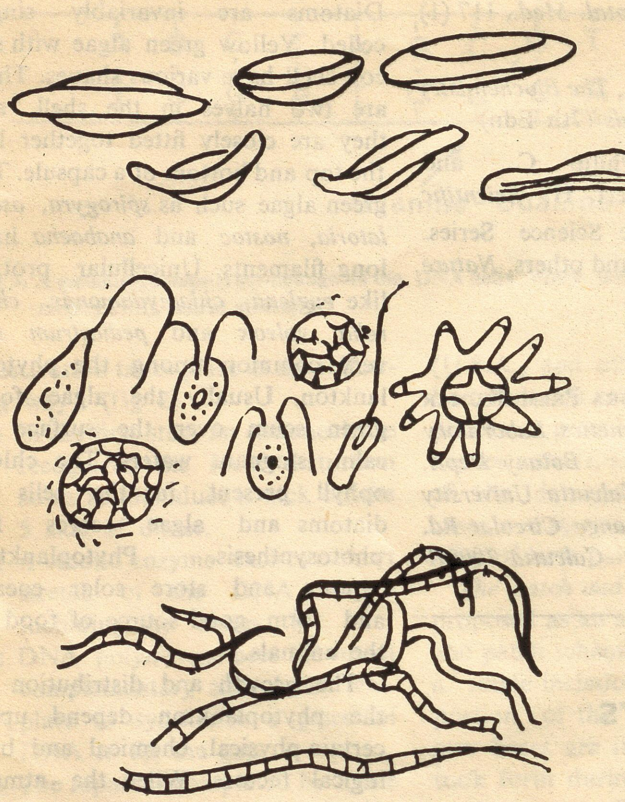

Fig 2. Zooplaokton

from the epilimnion (upper layers of water in a pond or lake). The absence of oxygen inhibits their growth and even leads to their sudden disappearance due to death and decomposition. The extent of organic decomposition, pH value, available nutrient minerals and the occurence of herbivore animals in that locality are other deciding factors in this respect.

Phytoplankton can be cultured very easily in the inland waters. If natural manures like dung and domestic refuse are added to the water in a pond, phytoplankton blooms can be observed in due course of time. Urea, superphosphate and other chemical fertilisers may also be used carefully according to the need.

Zooplankton

Eggs and larval forms of higher animals, copepods, cladocerans and rotifers are common among the freshwater zooplankton. The eggs and larvae are only temporary plankton. Crustacean larvae such as nauplius, zoaea and mysis are observed in certain seasons only. Calanoid and cyclopoid, copepods have long dorsoventrally compressed body. They resemble the common prawns in their shape, though very minute in size. Cladocerans have an oval body covered by bivalved carapace. Serrated caudal spine and a beak-like projection at the mouth region are present in species like daphnia. Rotifers are notorious in having a silicate spiny shell or 'lorica' covering their body, and a rotating ciliary mechanism surrounding the mouth, e.g., in bachionus, keretella and hexarthra

Food chains

Crustacean larval forms, copepods, daphinids etc. feed on phytoplankton and are known as herbivores or "primary consumers". Rotifers feed on small unicellular organisms. All these animals, in turu, are eaten by other animals—the "secondary consumers". Fishes and other higher animals are the consumers of the third order, however some of them are herbivores or the secondary consumers.

Diurnal migrations

This is a peculiar phenomenon exhibited by plankton. During day time the phytoplankton carry on photosynthesis and prepare food. But zooplankton that cannot tolerate light intensity remain at the lower levels of water where the effect of light is less. After sunset the planktonic animals begin to migrate vertically upwards and slowly reach the surface layers. They graze upon the phytoplankton or on primary consumers that assemble there. All these planktonic animals remain at the surface layers throughout the night, and also upto early hours of the next day. But at dawn they once again begin to sink down to the lower levels. This is a very common type of diurnal migration of the plankton There are however, many deviations from the common type.

Diurnal migration of plankton is usually known as "photoperiodism" as it is effected by light. Other physical factors such as temperature, water currents, etc. and the consequent hydrological and biological factors also affect them. These migrations are so rhythemic and seasonal that we can presume the level of occurrence of the plankton in lake waters by simply seeing the clock and calendar.

The obvious cause of the diurnal migration of plankton is the presence of food at the surface waters. Even if the food is made available at lower levels, or removed from the surface levels of water, the plankton begin to ascend up after sunset. Therefore, there may be some other inherent driving force in them which causes diurnal migrations.

Plankton and fisheries

The study of plankton and its diurnal migration helps explore and exploit the fresh water ecosystem. Carp fishes such as Catla, Labeo, Cirhinus, etc., prefer to live in the standing fresh waters and feed on the plankton. Fishes are extensively being cultured in the surroundings of Vijayawada and Kolleru in Andhra Pradesh. Carp fishes normally breed in the running waters. However, a new technique known as "induced breeding" has come to light recently. The adult fishes are given pituitary njections. Within days groups of fry appear. Feeding on the plankton they grow quickly. Tonnes of fishes can be harvested in an acre of land annually, provided the dangers of infection, overpopulation, and the predators are overcome. For an efficient management of a fish farm the knowledge of plankton and its culture is quite essential. The rate of fish catch in lakes and riverine reservoirs can be increased by studying the diurnal migration of the plankton in them.

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The nema tails

THE article **A tale of tails** by Drs. K. K. Tandon and Pushpinder Kaur (*S.R.*, Dec. 1976) makes interesting reading. While it is true that the tail is typically absent in a majority of the invertebrate groups, it is very much present in one group, the Nematoda.

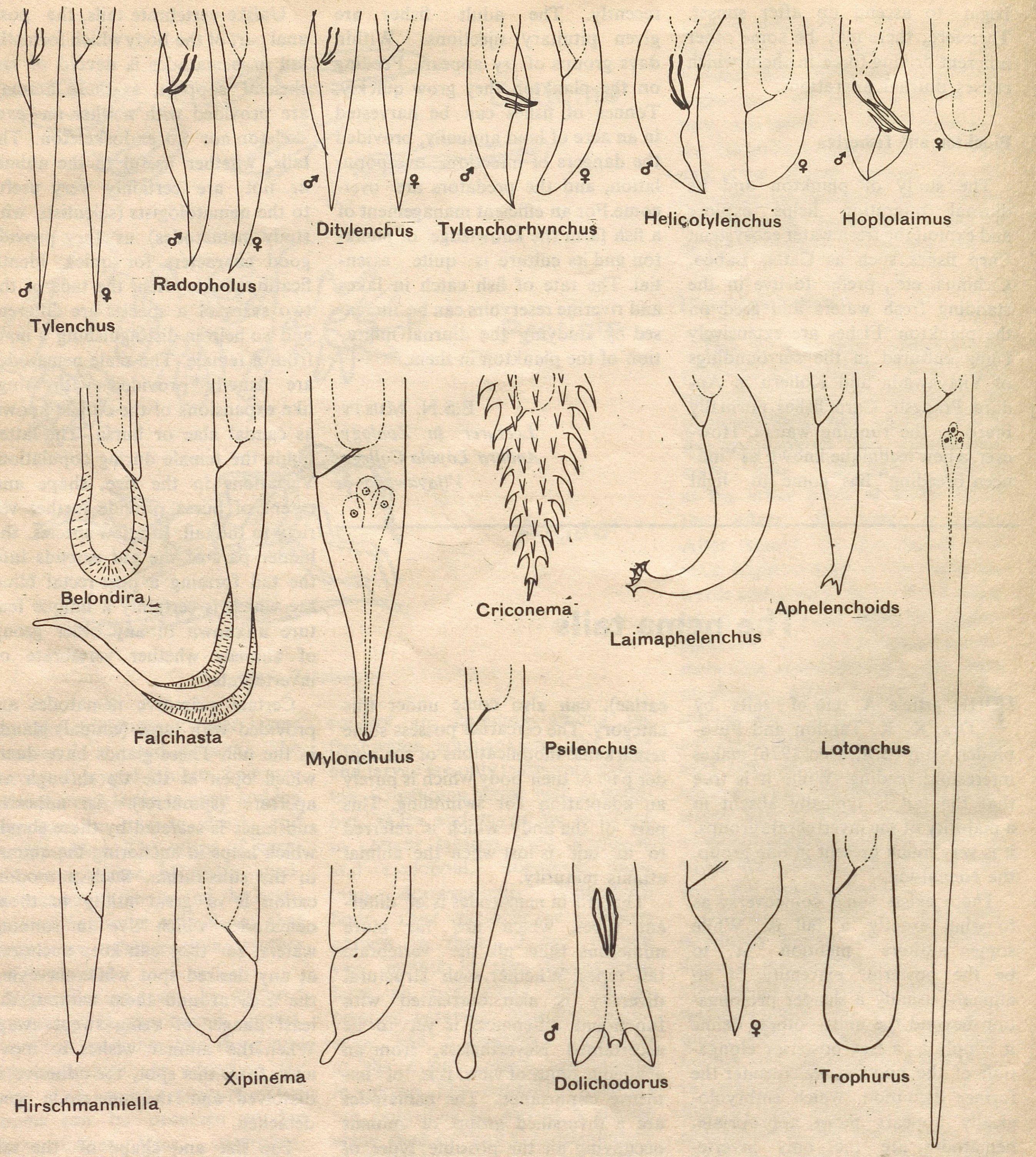
There exists some controversy as to what exactly a tail is. While some authors mention it to be the posterior extremity of an animal—usually a slender prolongation beyond the anus—others define it simply as a free posterior elongation of the body. If we consider the former definition, which embryologically appears more appropriate, nematodes are the only invertebrate animals which possess a true tail in the adult as well as in juvenile stages. However, considering the tail in a more generalized way as expressed in the latter view, the larval stages of Platyhelminthes, especially of trematodes (e.g., cercariae), can also come under this category. The cercariae possess some remarkable modifications of the hinder part of their body which is purely an adaptation for swimming. This part of the body which is referred to as 'tail' is lost when the animal attains maturity.

The tail in nematodes is of different types, which are far more numerous than all the vertebrate tail types. Whether such structural diversity is also correlated with functional differences is yet to be ascertained. Nevertheless, from an academic point of view, it is of immense importance. The nematodes are a diversified group of animals occupying all the possible types of habitat (marine, fresh-water, soil-inhabiting and parasites of plants, invertebrate and vertebrate animals). Some interesting types of tails that occur in nematodes, more particularly in the plant and soil-inhabiting forms, are given in Fig. 1.

Unlike vertebrate tails, the post-anal part of the body which formsthe tail in nematodes is devoid of any skeletal support, as these animals are provided with neither an exoskeleton nor an endoskeleton. The tails, whether useful to the animal or not, are certainly very useful to the nematologists (scientists who study nematodes) as they provide good characters for quick identification. Quite often, the tails of the two sexes of a species are different and so help in distinguishing a male from a female. The male nematodes are usually provided with wing-like expansions of the cuticle known as caudal alae or bursa. The latter holds the female during copulation. Variations in the size, shape and extent of bursa provide further variety to the tail. In a few species, the hinder part of the gut extends into the tail forming a post-rectal blind sac which is certainly a unique feature unknown in any other group of animals whether vertebrate or invertebrate.

Certain primitive nematodes are provided with large (caudal) glands in the tail. These glands have ducts which open at the tip through an aperture (spinneret). An adhesive substance is secreted by these glands which helps in anchoring the animal to the substratum. Such a modification is of great utility to those nematodes which live in running waters, for they can keep anchored at any desired spot while surveying the area around them without the least danger of being swept away. When the animal wishes to move away from this spot, the adhesive is dissolved and the nematode gets detached.

The size and shape of the tail varies in all the species of nematodes, but still it conforms to some broad types. In general, it shows a tendency of regression from the very long and filiform (e.g., *Tylenchus*) to a short and hemispheroidal tail (e.g., *Hoplolaimus*). Between these



Tail types in nematodes

two extreme types are found numerous intermediate types. Some of the significant ones are the elongate tails of *Radopholus*, elongate-conoid tails of *Ditylenchus*, conoid of *Tylenchorhynchus* and the bluntly rounded tails of *Helicotylenchus*. The males which possess a long tail incidentally have a small bursa restricted only to the anal region. However, with the gradual decrease in the length of tail, the extent of bursa increases which indicates that the bursa size is indirectly proportional to the tail length. In *Radopholus* and *Ditylen-*

chus males, more than half the tail is covered with bursa, while in *Tylenchorhynchus*, *Hoplolaimus*, etc., the tail is completely enveloped by these wing-like expansions.

Other interesting variations may be seen in *Hirschmanniella* and a few species of *Helicotylenchus* which are provided with one or rarely two spines (mucro) at their tail tips or *Aphelenchoides* and *Laimaphelenchus* which have cuticular ornamentations of different types. Digitate and mammalate tails are found in many species of *Xiphinema*. *Criconema* species have tails that are provided with sharp spines or blunt scales. Large and well developed caudal glands are present in *Mylonchulus*, while *Iotonchus* may have an exceptionally long whip-like tail. A very peculiar feature is present in *Falcihasta* which has fin-like expansions along the middle of the tail, but in species of *Belondira* the entire tail may be expanded and fin-like. The tail of *Psilenchus* is filiform but its terminus is peculiarly swollen, club-shaped; whereas the tail of *Trophurus* is short but entirely clubbed. The males of *Dolichodorus* have characteristic tri-lobed terminal bursa while their females have a short rounded tail which abruptly tapers to a sharp point.

The tail is evidently a locomotory organ and an aid in swimming especially in the marine and freshwater nematodes. However, the fact that it has persisted and remained equally pronounced in the majority of soil-inhabiting and parasitic species is amazing. Perhaps it represents a trait reminiscent of its aquatic ancestors. A closer study of the parasitic and non-parasitic forms reveals that with the gradual restriction (parasitism) in movement of the animal, the tail becomes progressively reduced. This fact is exemplified by some endo and semi-endoparasitic nematodes such as *Heterodera* and *Meloidogyne* in which the adult females lack a tail while the juveniles and the non-parasitic males have one. In some nematodes like *Xiphinema* the larval stages may possess tails longer than those of the adults although both are ectoparasites on the plant roots. Some recent observations have revealed that during the process of egg-laying the flexing of tail sharply increases which indicates that it may be aiding the process. The male during the process of copulation coils the tail tightly around the body of female and uses it in maintaining the correct posture during the act.

It can be concluded that diversity of tail types in nematodes certainly surpasses that of the entire vertebrate groups.

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Mass stranding of whales

STRANDING of whales attracts public attention. It is because, save the minor members of the whale family such as the porpoises and the dolphins, whales are rarely seen in the coastal waters. Stranding of whales enmass often causes panic among the fishermen. They interpret such phenomena as the wrath of sea gods and try to propitiate the angry gods by offering worship to the stranded ones.

Stranding of schools of whales has been reported from maritime countries like the U.S.A., U.K. and Australia. Such incidents are also on record from Indian coasts The recent one was beaching of more than 100 pilot whales off Manapadu on the east coast. The tendency to strand in shallow waters is prevalent among toothed whales. This tragedy is known to strike killer whales, false killer whales, pilot whales and even the giant sperm whales.

The peculiar nature of toothed whales to strand in shallow waters suggests some imperfection in their direction-finding mechanism. Whales use sounds in their navigation. The toothed ones produce high pitched clicks to locate preys as well as to stay clear of obstacles in their path. They are unable to find proper direction when their clicks are not reflected back. The gentle slope of the ocean floor or its muddy nature is sometimes responsible for the tragedy. The clicks are not reflected back by a muddy floor as the former are absorbed by the latter. Generally the great Baleens are free from the malady. They produce low pitched sounds which bend over the obstacles. They can sense the danger from a distance. Isolated strandings of Baleens may be either due to sickness or mortal injuries received from the propellers of passing ships or from predators like the killer whales.

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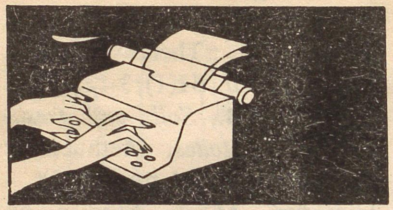

NEWS & NOTES

Prof. K. L. Chopra —Bhatnagar Award Winner

WHAT is the key to your success? One cannot resist the temptation of putting this question to a successful man, particularly to the one who is the recipient of the country's most prestigious scientific research award, the S. S. Bhatnagar Memorial Award of the C.S.I.R. The successful person in question in this interview is Prof. K. L. Chopra, of Department of Physics, I.I.T., New Delhi who shared the 1975 Physical Sciences Award with Dr. B. R. Nag, for his researches in Solid State Physics.

For the key to success, Prof. Chopra looks back to his days spent at the University of British Columbia, Canada. "The very first day I arrived at the University as a World University Service Fellow," mused he, "I expressed a desire to my supervisor that I would like to learn the workshop practice. Looking at me well-dressed, he was taken aback. But on my insistence, he took me to the workshop and asked one of the M. Sc. students to train me on his own job of threading a long brass rod. The student was enthusiastic in getting help, and he let me sweat on the job while he enjoyed smoking cigarettes. From that day on, I was determined to learn to work with a variety of machine tools, lathes, glassblowing, and repairing of instruments. It gave me a great pleasure to emulate the research students around me who did all their work by themselves. This attitude has stood me in good stead in my life as an experimental physicist". Today, according to him, this very attitude has become the key philosophy of his research school at I.I.T., New Delhi.

Indeed, for experimental work, a researcher should be prepared to labour for anything. The lack of such attitude in the country, a disrespect for manual work that has been perpetrated in our minds and culture through the last many centuries, is what hinders progress in science and technology. Theoretical science is certainly a luxury to be enjoyed by the developed countries, but for an underdeveloped country like ours experimental science is the only panacea. Prof. Chopra is very correct when he adds that "poor quality of scientific work in India has only a small connection with the lack of facilities. Primarily, it is due to lack of a scientific and technological culture, proper attitude, dedication and commitment on the part of the scientists working as a group".

Born on July 31, 1933, at Chahal Kalan, West Punjab (now Pakistan), Prof. Chopra did his early education at D.A.V. Higher Secondary School, N. Delhi, B. Sc. (Hons.) and M.Sc. at the University of Delhi, and went abroad for Ph.D. Belonging to a family of farmers and teachers, Prof. Chopra says that he did not receive encouragement outside his family. "It is so because we, as a nation, do not subscribe to the concept of encouraging and honouring our own talents." He should know better because he has spent seventeen years abroad, in countries such as Canada, West Germany and the U.S.A.

Since childhood, Prof. Chopra has marvelled at the wide variety of materials used by mankind. "I have often wondered how new materials could be created," he says, "and it is this curiosity which inspired me to take up research in Solid State Physics as a career". Today, he has received the Award for the outstanding contributions he has made to the understanding of the structure of thin films, the effect of electric fields on their growth and the effect of vacancies on electron transport. He also has developed novel techniques for growing thin films with special properties and useful applications, which are being adopted by the industry. Asked what he thinks about research as a career, he replied that "research in science should be undertaken by only those who have the commitment and devotion of a deeply religious man".

Prof. K. L. Chopra

Anything to say about science popularisation? His reply is quite pertinent. Prof. Chopra said, "Science can be popularised in India only if we have scientists who love to do science writing, have devotion and commitment, without any consideration to financial gains". He added, however, that the financial gains should, of course, be made available without asking.

DILIP M. SALWI

First International Symposium on avian endocrinology

THE First International Symposium on Avian Endocrinology was held at Calcutta, during January 10-15, 1977. It was convened by Professor Asok Ghosh, Sir Nilratan Sircar Professor of Zoology of the University of Calcutta. The Symposium was presided over by Professor Donald S. Farner, the Chairman of the Department of Zoology, University of Washington, Seattle, U.S.A.

The first international seminar on specialized aspects of avian endocrinology was held in Japan in 1969, under the leadership of Professors Farner and Kobayashi. The focal theme of the Calcutta seminar, however, cen tredaround the problems related to hypothalamic control and the avian reproduction.

India is fortunate in having quite a large population of this fascinating and economically significant group of vertebrates. India possesses about 1,200 avian species representing 20 orders as against about 8,600 species and 27 orders in the world. This is definitely a very high number and represents a great variety for any single country. Further, the birds we see in India are a splendid cross-section of the total avifauna of the world. The holding of the 'First International Symposium on Avian Endocrinology' in India is appropriate.

The applied avian endocrinology deals with the process of reproduction in birds like other group of vertebrates. It is dependent on the hormonal secretion and an understanding of this relationship can provide information that may be usefully applied when, for economic reasons we may wish to increase or control, the fecundity of a species.

Both theoretical and applied aspects of avian endocrinology was discussed and the role of hormones on poultry and egg production was emphasized. A number of papers were presented on pest birds and birds which are agriculturally beneficial and there was a general opinion that a scientific inventory on this aspect would certainly help avian endocrinologists all over the world in the biological control of pest birds and an increase in the population of the beneficial birds.

Birds are to a large extent economically beneficial; they are also, of course, scientifically interesting and aesthetically delightful. Yet some species become pests when present in large number or in the wrong places.'

Avian endocrinology is the study of endocrine glands in diverse species of birds including poultry, game and wild. The prime academic objective of this subject is to reconstruct evolutionary pathways by the study of living avian species. Apart from contributing to the over all phyletic study, we also aspire to rebuild the lines of evolution within the endocrine system itself taking both morphological and functional criteria in our account. We can concern ourselves with the molecular evolution of hormones, with the probable acquisition of new active sites conveying new properties and finally explaining the mechanism of hormone action in terms of receptor protein and consequent genetic effects.

The academic aims just described are not, however, sufficient justification for the men with a more materialistic outlook. The applied avian endocrinology is the answer to them. Although there is a respectable endocrinology of the poultry birds (particularly the chicken and not so much on the duck), there has been rather restricted concern with potentially egg and meat producing wild birds. Regarding the birds of agricultural importance, we must attempt to prepare an inventory, to determine which birds do harm, which is beneficial, and which is of neutral status; so as to which species should be encouraged near the agriculture and which should be discouraged. In the near future, we hope a full fledged discipline of 'Economic ornithological endocrinology' will emerge and prove particularly significant to the developing countries.

After the great success of this seminar, some of us started thinking whether holding an international symposium is possible encompassing multiple aspects of the avian endocrinology. Just about two years ago from now I had the fortune of meeting in Calcutta three top-most avian endocrinologists like Professors Farner, Kobayashi and Assenmacher. They all enthusiastically agreed to the proposal and with their approval we approached other distinguished scientists of the field. Their response was also tremendous.

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MEDICAL NOTES

Dental caries-causation and prevention

THE human teeth, gums and the oral mucosa are affected by a number of diseases and disorders. The most common dental diseases in India are the dental caries and the periodontal disease or pyorrhoea. Dental caries has been affecting the human teeth since times immemorial (Fig. 1). Tooth decay which is a major oral disease begins at an early age. Although susceptibility to dental caries is not established to be related to socio-economic level of the community, yet it has been observed so. Dental caries in the primary dentition may occur as early as in the first year of life. The caries pattern of a child is related to the caries pattern of his parents, his brothers and his sisters. At any given age, girls show a higher caries attack rate than boys. This difference is probably due to the earlier eruption of teeth in girls. There is a mention about caries in the *Sushruta Samhita* under affections of the mouth (Mukha-roga), where it has been called as *Krimi-dantaka.*

It is primarily a disease of hard tissues of the teeth, i.e., of enamel, dentin and cementum (Fig. 2). There is no resemblance of this disease to caries of the bone (bone tuberculosis). It is a progressive destruction and disintegration of the tooth substance. To start with, it is a painless and an irreversible process. It is an unique pathologic entity because whatever damage is done to the tooth by it cannot be undone by the repair processes of the human body. It is neither infectious nor contagious nor a congenital malformation.

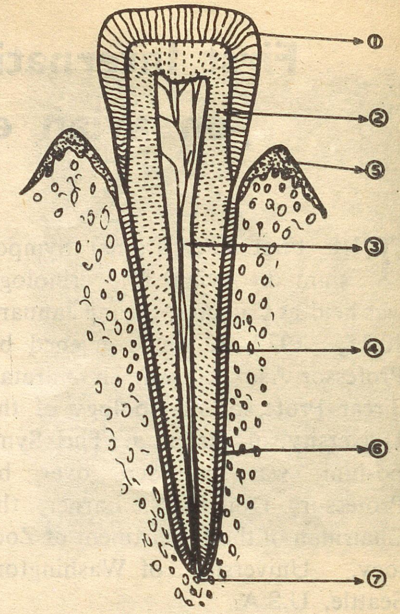

Fig. 2.

Incidence

It has been labelled as a disease of the Western countries but this is wrong. It is very much prevalent in our country. Different surveys conducted, in others as well as in this country, reveal that the incidence is on the increase not only in the developed countries but also in the developing countries. More and more children are affected by it. It is second important disease next to pyorrhoea for loss of teeth in Indians. G.F. Taylor and C.D. Marshal Day, Faculty of Dentistry, Punjab University, Lahore observed in 1939 a low incidence of caries in Kangra Valley in Punjab. C.D. Marshal Day and G.C. Tandon, Faculty of Dentistry, Punjab University, Lahore (1940), from another group of children in Punjab, recorded that caries was much less than in American children. K.L. Shourie, Nutrition Research Laboratories I. R.F.A., Coonoor (1941) made a comprehensive survey of children from various parts of India. He reported that 44.5% of children

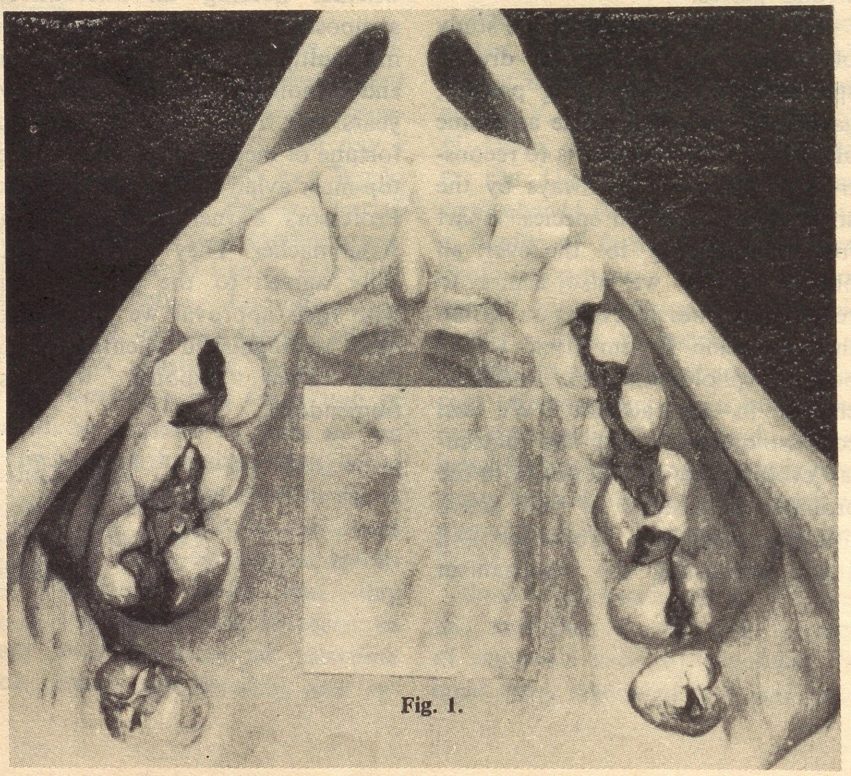

Fig. 1.

were free from caries which was considered to be much higher than that recorded in children in England and U.S.A. The incidence of caries in deciduous teeth was higher in girls than in boys. Urban children in all age groups showed more caries than the rural children. Thereafter, a number of surveys carried out by B.R. Vacher, Govt. Dental College & Hospital, Amritsar (1952), S.L. Mangi and V.P. Jalili, College of Dentistry, Indore (1961) showed the caries incidence to be on the increase.

Pathogens

How it is caused ? Dental caries has a multifactorial etiology not only from the point of micro-organisms but also from the consideration of amount and type of carbohydrates used. The physical and chemical properties of saliva may influence dental caries susceptibility. There are three major factors in the pathogenesis of dental caries: (i) the fermentable carbohydrate foodstuff, (ii) the oral microbial enzymes, and (iii) the physical and chemical composition of the tooth surface. The first two may be considered as attack forces and the tooth surface as the resistance force. The oral cavity may be said to be a good incubator. There are millions of micro-organisms in the mouth. There are no means to make the oral cavity sterile of bacteria nor we wish to do so. Whatever food we eat is first incised and masticated by teeth and then swallowed. Micro-organisms and their enzymes help in the fermentation and degradation of the food. They help in the production of acids such as lactic, pyruvic, acetic, propionic and butyric. About 18 species of bacteria have been isolated from the mouth. They have been found to be actively associated with caries production and the most important of them is Lactobacillus *Acidophilus odontolyticus*. This particular micro-organism can live at a pH of 3.5. It is both acidogenic and aciduric, i.e., it produces acids and lives in an acidic medium. So cooked or boiled carbohydrates in our food are fermented and broken down into acids with the help of enzymes secreted by the micro-organisms. When the teeth are not cleaned regularly, the plaques of food are formed on the tooth surface. The acids accumulate under the plaque and come in contact with the tooth surface. When the pH of the acids reaches 5.5 or below, it causes demineralization of tooth substance, i.e., the inorganic salts are dissolved and the organic matter disintegrated or liquified to form a cavity. This theory is called chemico-parastic theory. There are other theories as well but not so widely accepted. Inspite of all the research on this subject, there is no single theory to explain all aspects of this disease. It may be important to know here that the enamel of the tooth is 96% inorganic salts and 4% organic matter and water.

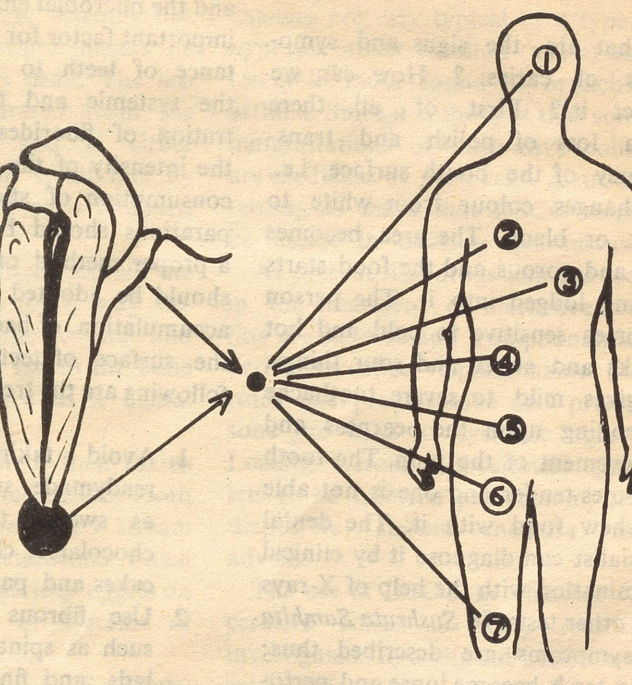

Fig. 3.

The mechanism of caries production in short, is as follows:

$$\text{Carbohydrates} \xrightarrow{\text{Enzymes}} \text{Acids} \xrightarrow[\text{5.5 or below}]{\text{pH}} \text{Demineralization} \xrightarrow{\text{Micro-organisms}} \text{Liquefaction} \longrightarrow \text{Caries}$$

Types

Caries of the teeth could be acute or rampant when the susceptibility is very high. Almost all surfaces of the teeth are affected. Even the very immune areas, viz, the cervical and proximal surfaces of mandibular incisors are involved. The other type is chronic or slow growing. It may involve one tooth or a group of teeth at the same time. There is another type called arrested, where further progress of caries does not take place because the area had become self-cleansable and the secondary dentin has formed.

Features

What are the signs and symptoms of caries. ? How can we detect it ? First of all, there is a loss of polish and translucency of the booth surface, i.e., it changes colour from white to dark or black. The area becomes soft and porous and the food starts getting lodged into it. The person becomes sensitive to cold and hot drinks and sweet and sour things. It gives mild to severe toothache depending upon the nearness and involvement of the pulp. The tooth becomes tender and one is not able to chew food with it. The dental specialist can diagnose it by clinical examination with the help of X-rays and other tests. In *Sushruta Samhita* the symptoms are described thus: "The teeth become loose and perforated by black holes accompanied by a copious flow of saliva. The appearance of an extremely diffused swelling (about the roots of decayed teeth) with a sudden aggravation of the accompanying pain without any apparent cause is also one of its specific features". Once the pulp is involved, it becomes a passage for the oral micro-organisms to travel into the bone. Swelling appears into that area and other complications of inflammation follow.

Treatment

There is no medicinal or radical cure for it. The key to good health is prevention, and that is true to this disease too. In *Sushruta Samhita* the following has been said: "A person suffering from any affection of the teeth should refrain from taking acid fruits, cold water, dry food, excessively hard articles of food and brushing teeth with a twig". There are two major methods of preventing dental caries. The first is by increasing the resistance of tooth enamel to external attack. The second is to reduce the intensity of the attacking agents, i.e., the fermentable carbohydrates and the microbial enzymes. The most important factor for promoting resistance of teeth to dental caries is the systemic and topical administration of fluorides. For reducing the intensity of the attacking agents consumption of sticky, sugary preparations should be restricted and a proper method of tooth cleansing should be adopted to reduce the accumulation of bacterial plaque on the surface of teeth. In short, the following are the treatment measures:

1. Avoid taking candies and readymade sugary items such as sweets, toffees, lollipops, chocolates, chicklets, biscuits, cakes and pasteries.
2. Use fibrous detergent food such as spinach, cabbage, salads, and finish the meal by an apple or a carrot.
3. Ideally, brush your teeth after each meal; if not, at least twice in twenty-four hours, once at night before going to bed and once in the morning after the breakfast. After dinner we are going to have a sleep for 6-8 hours. If we do not brush after dinner, the food particles which are left in the mouth will ferment and help in caries production. Similarly, our breakfast consists of more of soft, sticky food articles like bread, biscuits, etc., hence teeth should be brushed after breakfast. Also do a finger or a terry (cloth wrapped on a finger) massage. After lunch a thorough rinse will be good. One should not take anything in between the meals. Chewing betel leaf, nuts and suparis should be avoided.
4. Pregnant and lactating mothers should take nourishing food so that their newborns have strong and well formed teeth.
5. Use of fluoride in several ways helps reduce caries incidence. Fluoridation of community drinking water is an important means of doing so. Fluoride is added in the ratio of 1 part per million parts of water. This limit should not exceed.
6. Topical application of fluorides on the freshly erupted teeth in children may be done at intervals.
7. Dental pastes and powders containing fluorides should be used.
8. Fluoride tablets are used as a tonic for teeth and fluoride in milk powders is advocated when it is deficient in drinking water.
9. Use of sealants and prophylactic odontotomy is advisable to prevent initiation of caries.
10. Proper intake of calcium, vit. D and phosphorous during the development of teeth is desirable.
11. Mouth should be properly rehabilitated. There should be no ill-fitting dentures or restorations.

The curative treatment, however, consists of removal of carious tissue and restoring it by artificial means like cements, eugenol pastes, acrylic resins, alloys. gold inlays and crowns. In advanced cases pulpotomy is undertaken, i.e., the pulpal tissue is partially or completely extirpated and then the tooth is filled. These teeth could also be saved by a process of replantation in which case the affected tooth is extracted, cleaned, treated and inserted back into its original position. It is maintained by wiring/splints till it has stabilized. The carious tooth may be replaced by another otherwise healthy tooth such as embedded canine, or a wisdom tooth from the same individual. This is called autotransplantation. The affected tooth which otherwise cannot be treated should be extracted to control the carious process. Here under are noted complications of untreated caries:

1. Pulpitis is the inflammation of pulpal tissue in the tooth cavity. The tooth becomes very tender and there is a severe pain on taking drinks, especially the hot ones.
2. The pulpitis may lead to infection of bone around the apex of the root of the tooth.
3. The apical infection of bone may lead to the formation of an alveolar abscess.
4. An abscess can lead to a situation like cellulitis of floor of the mouth cavity causing asphyxia, i.e., choking.
5. The abscess may burst on the skin and form a sinus or sinuses. It may communicate with the maxillary antrum and form an oro-antral fistula.
6. The abscess can cause necrosis of bone, i.e., osteomyelitis of the jaws which means the bone becomes dead. The latter gets separated from the healthy bone and is either thrown out in small bits by the body itself or is removed surgically.
7. The infected tissue around the root tip of a tooth may degenerate in the centre and form a closed sac in the bone which is termed as a dental cyst.
8. The bacteria and their toxins from the infected carious tooth may enter the blood stream leading to becteraemia which may have deleterious effects on other organs or systems of the body (Fig. 3).

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Cromolyn use in ulcerative colitis

THE use of di-sodium cromoglycate or cromolyn (Intal) as an effective anti-asthmatic had been already discussed (Laha, N. N., *Science Reporter*, April 1976, p. 247). The drug di-sodium cromoglycate (DSCG) is a derivative of khellin, an active principle in a herb called *Amni visnaga*. Presently, DSCG has attracted gastroenterologists who have found out that this drug may also be beneficial for those who suffer from ulcerative colitis.

Ulcerative colitis is a disease of colon (large bowel) and rectum. It is a chronic, non-specific inflammatory disease. The cause of the disease is unknown. It usually starts in the rectum (then called ulcerative proctitis) and spreads towards the caecum. Age groups between 20 to 40 years are usually affected. The severity varies from person to person, from mild diarrhoea and occasional bleeding to severe and exhausting diarrhoea and signs of dehydration. The colon is inflammed and ulcerated with multiple bleeding points.

Microscopically, the disease is confined to the mucosa usually, rarely extending to deeper layers and shows inflammatory changes. There is an increase in the number of plasma cells, eosinophils and mast cells which have lost their granules. The histamine content of the colon is very high during a relapse. These changes are very typical of a type 1 hypersensitivity reaction (acute) and resemble those found in bronchial asthma. Since it is thought that some manifestations of ulcerative colitis are mediated by mast cells, gastroenterologists think that DSCG might be useful in treating this disease.

At present, the drugs that are used in the treatment of ulcerative colitis are steroids and a sulphonamide derivative called sulphasalazine. Steroids like prednisolone and prednisone are used as systemic agents. Locally, steroid suppositories (tablets to be inserted per rectum) and disposible steroid enemata are advised.

The use of DSCG in treating ulcerative colitis is being recently investigated. In a clinical trial, it was said (*Brit. Med. Journ., 1. p. 2* 1976) to have produced appreciable response in about 50% of cases. DSCG was given orally in a dose of about 300 mg/day and as an enema (200 mg) to 26 patients employing double blind cross over technique, with two treatment periods of four weeks. 14 patients (about 50%) showed considerable improvement and 10 had no benefits whatsoever.

Another paper by V. Mani and his colleagues which appeared in *Lancet* (28th Feb., 1976, p. 439), reports considerable improvement in the symptoms and signs of ulcerative colitis and proctitis (affecting both colon and rectum) following treatment with oral DSCG. The drug is not absorbed and acts topically. Both papers definitely suggest that DSCG may be of some benefit in the treatment of ulcerative colitis.

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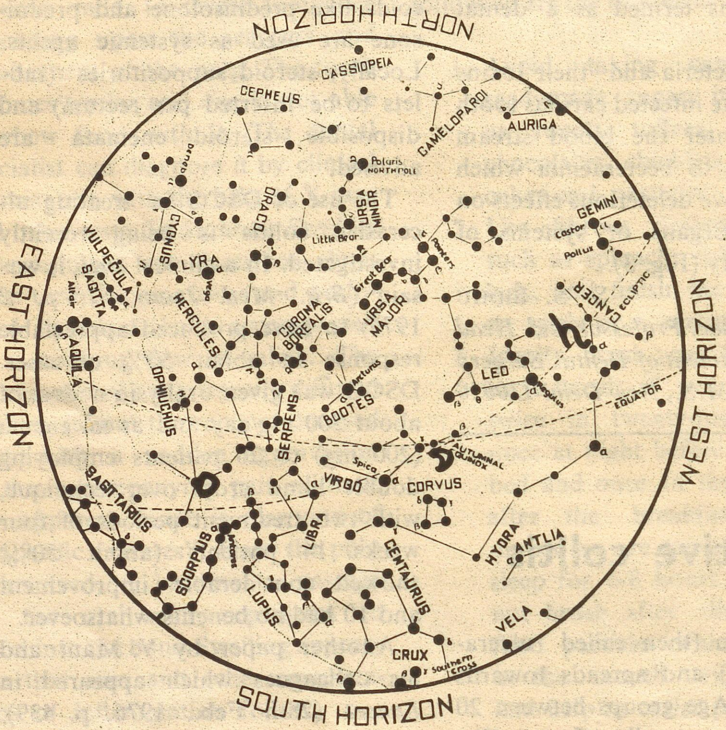
Planets and their positions

JUNE 1977



PLANET — MAGNITUDES -1 0 ·1 ·2 ·3 ·4 ·5 — MOON

♄ SATURN — ○ FULL MOON 2ND

☽ FIRST QUARTER 24TH

The moon

FULL moon occurs on 2nd at 2-01 a.m. and new moon on 16th at 11-53 p.m. I.S.T. The moon passes very close to Mars and also about one and a half degrees north of Venus on 12th, about two degrees south of Mercury on 15th and six degrees south of Saturn on 21st. The lunar crescent becomes first visible after the new moon day in the evening of 18th.

The moon is at perigee or nearest to the earth on the 1st and again on 30th and at apogee or farthest from it on 15th. The sun is at the summer solstice on 21st.

The planets

Mercury (Budha), a morning star, rises about an hour before sunrise during the first three quarters of the month. Thereafter, it is too near the sun to be visible. It is in superior conjunction on 30th. It passes about five degrees north of the star Aldebaran (*Rohini*) in the evening of 16th. It moves from Aries (*Mesha*) to Gemini (*Mithuna*) through Taurus (*Vrisha*). Its visual magnitude varies from +0.5 to—1.1.

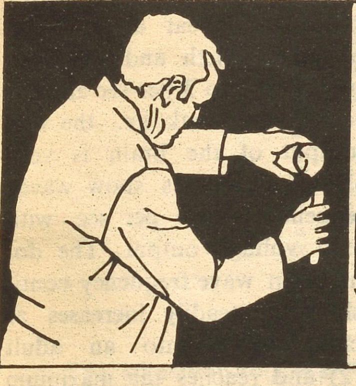
Venus (Sukra), visible in the morning sky, rises about two hours after local midnight during the month. It passes about a degree south of Mars on evening of 3rd. It is at the greatest western elongation of 46 degrees from the sun on 15th. It is in Aries (*Mesha*). Its visual magnitude is about—4.0.

Mars (Mangala), a morning star, rises about two hours after local midnight during the month. It is in Aries (*Mesha*). Its visual magnitude is about + 1.3.

Jupiter (Brihaspati) is too near the sun to be visible during the first half of the month. It is in conjunction with the sun on 4th. Thereafter, it reappears as a morning star and rises about an hour before sunrise. It is in Taurus (*Vrisha*). Its visual magnitude is about—1.5.

Saturn (Sani), visible in the evening sky, sets about two hours before local midnight during the first half of the month and about three hours before it during the second half. It is an Cancer (*Karkata*). Its visual magnitude is about +0.6.

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



SCIENCE FOR THE YOUNG

Brain waves or EEGs

THE nervous system of the human body, in fact, of all animals, is a marvellous communication network of which the central exchange is the brain. All sensations, for example, the sensations of touch, hearing, sight, taste and smell etc., are communicated to the brain as electric impulses which travel along the nerves at a speed of about 100 meters per second. There is a gap of about two millionth of a centimeter at the point where one nerve ends and another begins. These gaps are called synapses and the nerve endings are called neurons. The synapses work because an impulse arriving at the junction between two neurons (i.e., nerve terminals) releases a chemical substance that crosses over the gap and activates the neuron on the opposite side. All this happens within a millisecond or so. The body uses in one place chemical and at another place electrical process to get nerve impulses underway.

The brain receives messages from different parts of the body through the nerves, and communicates its order to various muscles through another set of nerves called motor nerves. These nerve fibres emerging from the brain pass through the spinal cord and end upon various muscle fibres. There are again synapses between nerve endings and the muscle fibres.

The human brain contains approximately ten billion nerve cells, each of which can generate a sizeable electric discharge. Besides the nerve cells, the brain contains about 100 billion glia cells. Each glia cell is a miniature biological electric battery. It is indeed a marvellous feat of nature to successfully pack such an enormous number of electric generators inside the small human head and yet make them cooperate and collaborate with one another efficiently.

Some net electrical output from all these electrical generators, so tightly packed inside the brain, can be measured by recording devices such as those used on single cells. The electrical output of the brain is tapped off the skull by attaching electrodes to the skull and connecting them through amplifiers to a recording oscillogram which shows and records the ups and downs of the electrical output of the brain. These ups and downs (or fluctuations) of the electrical output of the brain are called brainwaves. The brain waves tapped off the skull of a man are one of the most dramatic demonstrations of bioelectricity.

Doctors call these brain waves Electro-Encephalogram (EEG) just as the recorded electrical output of the heart muscles is called electro-cardiogram (ECG). In 1875 an Englishman named Caton published the first description of these brainwaves or the ups and downs of the electrical output picked up by wires attached to the exposed brain of a dog. The EEG studies were begun in earnest by the Austrian psychiatrist Berger who published twenty research reports between 1929 and 1938. Since then, thousands of papers by scien-

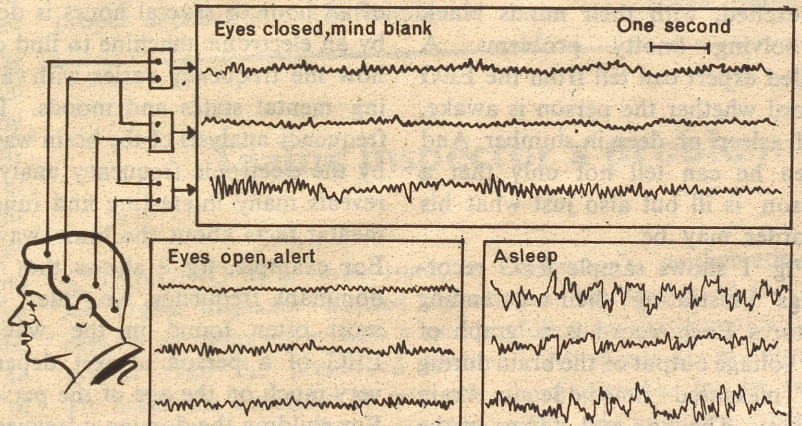


Fig. 1. Brain waves recorded simultaneously from front, middle and back of man's head. Waves from back of the head changed with subject's state of mind

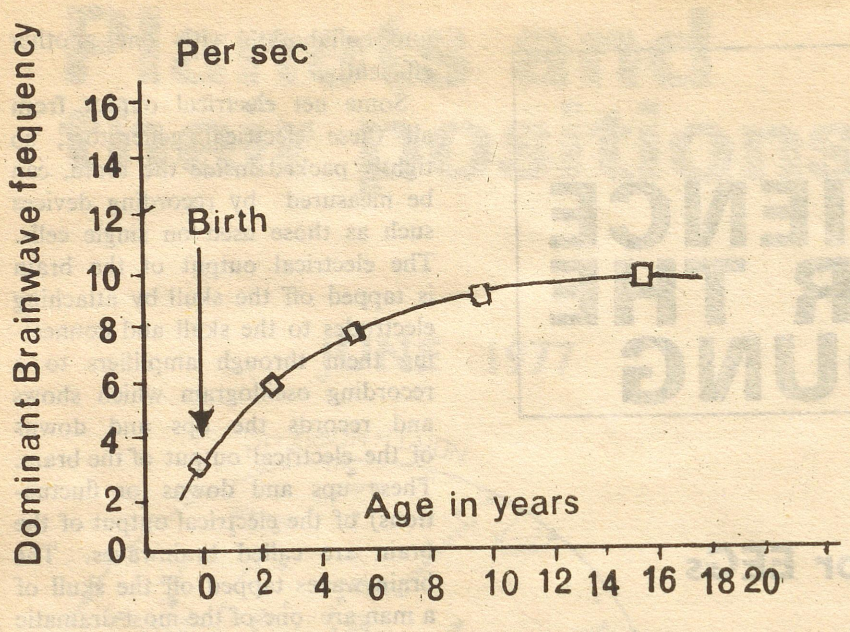


Fig. 2. Graph based on EEG recordings from hundreds of youngsters. Dominent EEG frequency rises is an orderly manner as children grow up

tists all over the world have filled the shelves of scientific libraries. Now-a-days, a close and intimate contact of the electrode, i.e., the wire terminal, with the brain nerves is not at all necessary. We have now vacuum tube amplifiers which can amplify a weak electrical output 10,000 times. They make it easy to detect and record human or animal brain waves from outside the skull through even a very thick layer of skin and bone.

In modern hospitals every day thousands of EEGs are taken from people asleep or awake, relaxed or excited, with their minds blank or solving knotty problems. A skilled expert can tell from the EEG record whether the person is awake, half asleep or deep in slumber. And often he can tell not only that a person is ill but also just what his disorder may be.

Fig. 1 shows sample EEG recordings illustrating their outstanding features. Each record is a graph of the voltage output of the brain during the measured time due to brain activity. The ups and downs in the graph are the waves and the distance along the graph measures the time. So by counting the number of ups and downs on the graph, over a length representing one second, one can measure the 'number of waves per second' which is called the frequency of the waves. The magnitude of the ups and downs, i.e., the amplitude of the waves is no less significant. If we count the number of waves per sec in various parts of the figure, we shall find the same to be at one place 10, at another 13, at the third place 2 and yet at another place 40. The counting of waves per sec or the frequency of the brain waves over a period of an hour or several hours is done by an electronic machine to find out how the frequency varies with varying mental states and moods. The frequency analysis of the brain waves by the electronic frequency analyses reveals many interesting and fundamental facts about the brain waves. For example, fig. 2 shows that the dominant frequency, i.e., the one most often found in the waking EEG of a person at rest depends very much on the age of the person. For children the dominant frequency varies from 3 to 5 per sec while in adults the same varies from 8 to 12 per sec. It is also known from such studies that the brain waves first begin to appear about three months before birth and they have a frequency of 1 to 3 per sec and are electrically very weak, i.e., the voltage output of the brain is very low. Newborn babies show waves of frequency 2 to 5 per sec with increased voltage output. The dominant brain wave frequency continuously and steadily increases as the child grows into an adult (Fig. 2) and reaches the maximum at about the age of 17. Attempt to relate this progressive rise in the dominant frequency to the changes in behaviour, interest and intellectual capacity as the child grows up to be an adult and beyond, form a fascinating chapter in the story of how physicians and psychologists use physical tools to understand biological processes.

The frequency of the brain waves generated during a period of several minutes can reveal some characteristic features. For example, Fig. 3 shows the frequency distribution of the brain waves of a person who during the recording was relaxed and awake, alert and attentive, or asleep. When awake frequencies round 10 per sec are present continuously. This normal rhythm of the brain waves is called the alpha rhythm. Inspite of the predominance of the alpha rhythm, frequencies around 5 per sec (called theta rhythm) and 20 to 25 per sec (called beta rhythm) also appear occasionally. When the person is alert the frequencies are mostly in the beta range. Besides human beings, animals like cats and monkeys show mostly beta waves in states of attention, problem solving and similar situations. During sleep the brain waves have frequencies of 1 to 5 per sec (delta waves). During a spell of moderately deep-sleep the brain waves have a frequency of 13 per sec. Fig. 4 is an imaginary analysis of the brain waves recorded from a normal person throughout a 24 hour period.

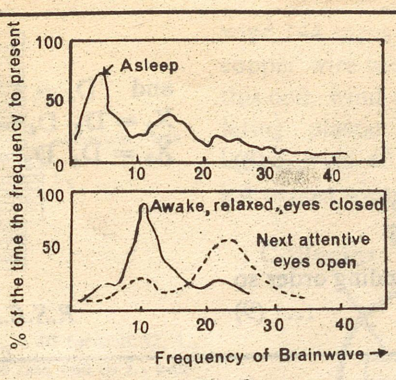


Fig 3.

To an astonishing degree the brain waves of all animals look alike. Approximately the same frequencies of the same amplitude are generated by the brains of all the higher vertebrates and most of the EEG variations occurring with emotion and action of a man show up also in similar situations in cats, dogs and monkeys. Relying on the similarity of EEGs of man and animals, most experiments are being carried on with animals in whose brains the EEG pickup wires are permanently embedded so that the experimenter can observe the electrical activity occurring at a particular place of the brain over a period of weeks or months. The experimental animal is thereafter put to death in a humane manner and the brain is prepared for study under the microscope.

Learning anything new must involve some reorganisation among the billions of cells inside the brain. The riddle of what becomes organised and how still remains to be understood and explained. Every animal including man is born with a basic pattern of behaviour determined by inborn instincts like hunger, self-preservation and the urge to reproduce the species. But every individual member of a given species modifies the basic pattern of its behaviour to adapt itself to the world it lives in, or in other words, it learns to live appropriately. The ability to learn is not limited of course to ourselves, but extends from the top to the bottom of the animal scale. Oysters and octopuses, parrots and elephants, one and all, form new habits, i.e., learn new patterns of behaviour as they grow up and gradually and progressively are exposed to their environment.

Some recent EEG measurements made on the brain, during learning, outline the newest and most exciting field of biological research. Change in the pattern of brain wave associated with learning was first studied over 40 years ago. At present scientists in many countries are trying new experiments to relate EEG to learning. In this worldwide research effort the EEG of fish, turtles, birds and cats and many other species of animals have been examined. Their efforts have disclosed many neat relationships showing EEG changes during learning. But the researchers admit that only the surface of the problem has been touched.

Yet most of them believe that by proper application of the techniques of physics and chemistry they will be able to understand the physical principles through which the brain cells drive the animals and human beings to do the many things they are able to do. Nevertheless, we are yet pitifully ignorant of how the brain works.

Perhaps a breakthrough will be achieved from experiments in which the brain will be studied not as a collection of nerves alone but as a community of nerve cells and glia cells snugly tucked inside the skull. Glia cells outnumber nerve cells by 10 to 1. Alongwith the neurons that they surround, the glia cells might even have an important role in generating EEG, the IPSP (Inhibitory Post-Synaptic Potential) and perhaps might even be involved in learning.

However thoroughly the human brain may be studied as a whole, however thoroughly it may be explored point to point by means of electrodes connected to the EEG machine, it seems that man will never be able to locate the seat of the master controller and director of the brain, I mean, the ego, the soul, the *Atman*, whatever you call it, who thinks, who wills, who creates works of art and science, who takes a particular decision in a particular situation to act in a particular way !

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Traffic inspector's problem

STANDING at a cross-road, a Traffic Inspector noticed three cars on his radar screen with a speed greater than the prescribed limit. He asked his constable to note the speeds. The constable noted the speed. But, being a cranky mathematician, he thought of testing the inspector's mathematics. He told him the speeds of the cars in the following mathematical jargon :

All speeds are in descending order and divisible by an odd number. This odd number is equal to the sum of two digits of the last car's speed. One less in a hundred gives the sum of two car speeds. Reversing the digits of first car gives second car's speed. Adding one hundred to each car's speed and then summing it gives a number equal to a section number. This section number is one under which a fraud case is registered. The difference between the digits of first car speed number gives the above odd number. What are the speeds of the cars ?

Solution

Suppose 1st, 2nd and 3rd cars have speed X_1, X_2, X_3 respectively.

$$X_1 + X_2 = 99 \quad \ldots (1)$$

Since the inspector states about the section number applicable for the fraud, and it is 420. So we get

$$(X_1+100) + (X_2+100) + (X_3+100) = 420 \quad \ldots (2)$$

By solving equation number (1) and (2) we get :

$$X_3 = 120-99 = 21 \quad \ldots (3)$$

The odd number is equal to the addition of third car speed, so it is $2+1 = 3$ ... (4)

Since all speeds are divisible by this odd number and none has got more than 2 digits, so:

$$\left.\begin{array}{l} X_1 < 99 \\ X_2 < 99 \end{array}\right\} \quad \ldots (5)$$

Suppose $X_1 = D_3 D_4$ ... (6)

D_3, D_4 are two digits of 1st car speed.

By reversing these digits, we get second car speed

$$X_2 = D_4 D_3 \quad \ldots (7)$$

Since the difference of the digits of 1st car speed gives the odd number as obtained in equation (4), X_1 will have one digit an odd number and other one even number. It is also there in the question that it is divisible by 3, therefore :

$$\left.\begin{array}{l} D_3 < 9 \\ D_4 < 9 \end{array}\right\} \quad \ldots (8)$$

Digits may be 3 or 6

D_3 may be 3 or 6

But speeds are in descending order so

$$D_3 = 6 \quad \ldots (9)$$

and $D_4 = 3$ ... (10)

$$X_1 = D_3 D_4 = 63 \quad \ldots (11)$$

$$X_2 = D_4 D_3 = 36 \quad \ldots (12)$$

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Do it at your home

Positive feed-back recevier

IN the last issue, how to make a diode radio reciever not powered by any source of electricity was described. This radio can only work if it is near a radio station. For fringe reception a very long antenna would be necessary. Now, how to make a single transistor regenerative radio reciever which will give satisfactory reception in almost any part of the country except the fringe areas is described below.

A germanium high-frequency transistor AF117 is used as per the circuit given in Fig. 1. Part of the output, it could be seen from the circuit, is fed back in phase with the input through a tickler coil. The feedback is controlled with a potentiometer, otherwise the circuit will behave as an oscillator with a high feedback and high input.

The input is taken through a padder capacitor C_1. 500F and is fed back to the tuning assembly C_2, L_1. L_1. is inductively coupled to the feedback coil L_2. From here the input goes to the detector/amplifier trans-

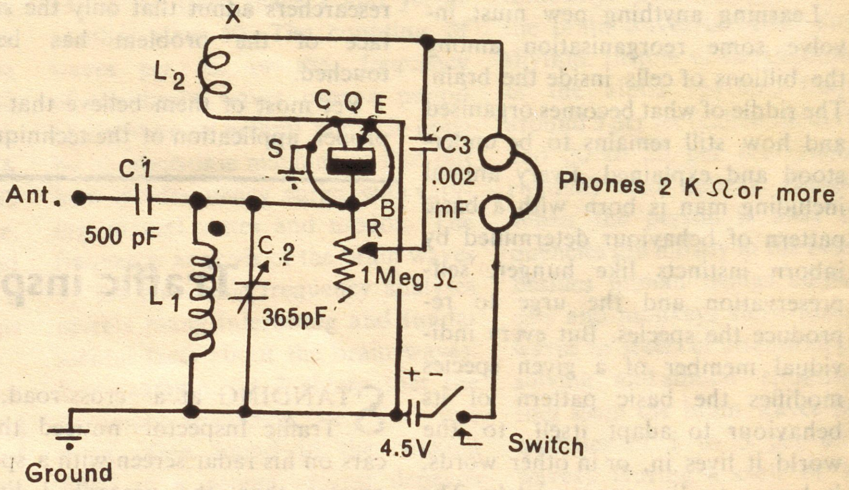

Fig. 1 Circut, C_1 : 500pF padder; C_2: 365 pF variable; C_3: .002 μF ceramic ; R: 1 Meg linear potentiometer (use the centreterminal and anyone of the other too; Q:AF 117; L_1, L_2 Ref. text Fig.2; Cell:4.5 (3 Penlight); Switch:toggle

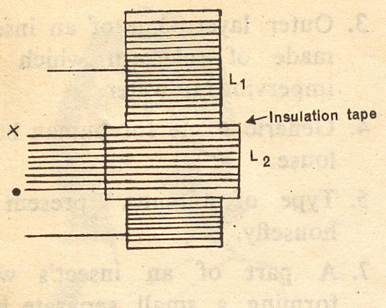

Fig. 2. Coil assembly: L_2 : 40 turns # 32, L_2 40 turns # 32 on one end of L_1 and in the same direction, coil from: 2.5 cm dia. plastic tube

istor Q through the capacitor C_3. Part of the output from this common emitter setup is fed back and the rest goes to the headphone.

The high sensitivity of the circuit is due to the positive feedback. As a part of the amplified signal is fed back in such a way that it strengthens the original signal, even a weak signal is fortified. Excellent fringe reception is therefore possible.

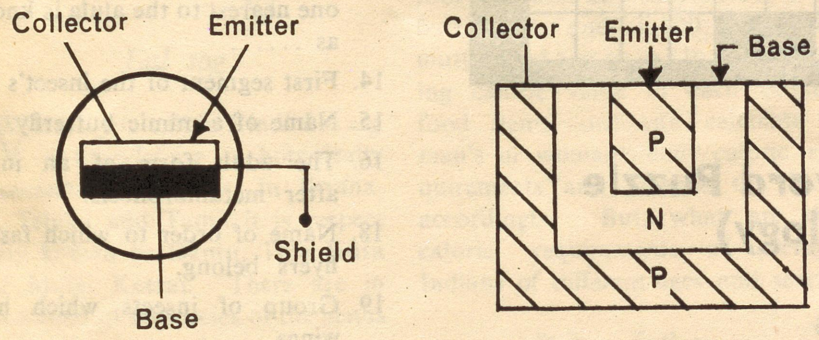

Fig. 3. (i) p-n-p transistor

The circuit has its attendant problems. Any hum or noise in any part of the circuit is also fed back and correspondingly strengthened. So therefore it is advisable not to operate this radio receiver on an eliminator, as the mains hum of 50 Hz would then be audible and annoying. A good grounding is also necessary, preferably a water tap or a metal spike in the ground, and be sure to connect the shield terminal of the transistor (marked S) to this ground.

The coil has to be hand-wound. On a 2.5 cm diameter plastic tube, wind 144 turns of No. 32 enamelled copper wire neatly. Over one end of this coil, wind a single turn of insulating plastic tape. On this insulation, wind 40 turns of the enamelled copper wire in the same direction as the coil underneath. Fig. 2 shows a schematic representation of the coil, as proper phasing of the feedback is necessary: the proper ends (marked by a dot and a cross) must be connected to the proper points (correspondingly marked by a dot and a cross) in the circuit.

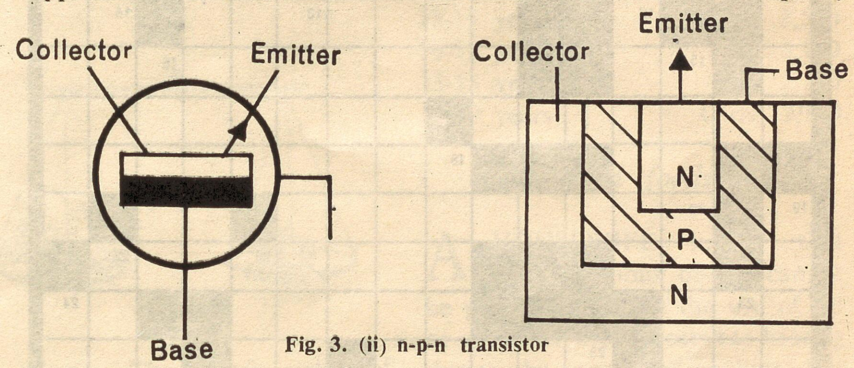

Fig. 3. (ii) n-p-n transistor

The headphone is one with an impedance of 2 kilo-ohms or more. It has already been described in the previous issue (S.R. April, 77) in some detail.

The tuning condenser is a standard 365pF tuning unit, usually available in a combination of two in a housing operated by the same knob. There are three terminals outside. Use the centre one and any one of the other terminals.

A transistor has three components. In a P-N-P transistor there are two layers of P-material (a technical term: it just means silicon or germanium with some metallic impurity of valency 3) in between which there is a layer of N-material (silicon/germanium with some metallic impurity of valency 5.) In an N-P-N transistor it is the other way round. The middle layer is called the base and the outer ones the emitter and the collector. In Fig. 3 (i) and (ii) the emitter has an arrow on it, pointing inwards in a P-N-P transistor and outwards in an N-P-N one.

If a signal is imposed across the emitter and the base, and if for a P-N-P transistor the emitter is positive W.R.T. the base and the collecter negative, then an amplified signal is available across the collector and the emitter. For and N-P-N transitor, the polarities are inverted. If you are not conversant with a transistor, the base diagram of the transistor is given (Fig 4) indicating the base, the emitter, the collector and the shield terminals.

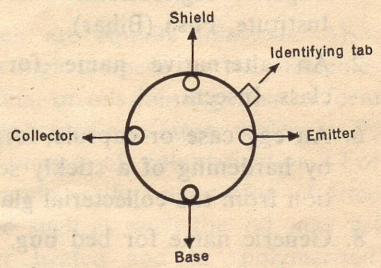

Fig. 4. Bottom view of AF 117

Use a 1 megaohm linear potentiometer for R.

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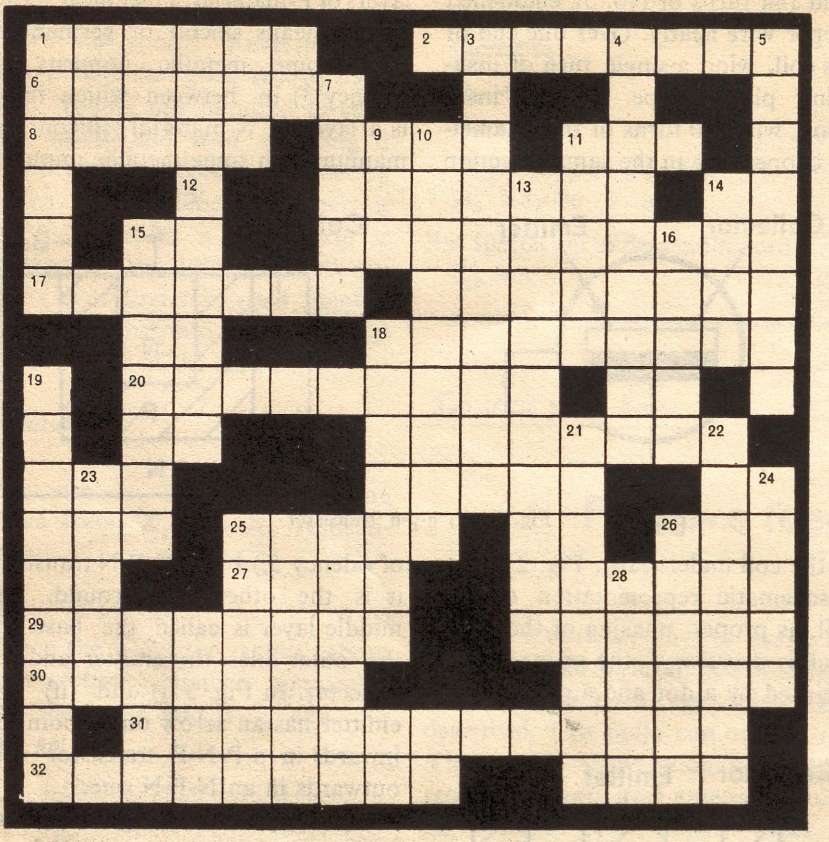

Science Crossword Puzzle (Entomology)

CLUES

Across

1. First Imperial Entomologist at Imperial Agricultural Research Institute, Pusa (Bihar).
2. An alternative name for the class Insecta.
6. An egg case or capsule, formed by hardening of a stickly secretion from the collecterial glands.
8. Generic name for bed bug.
11. An organic contact insecticide.
17. The breathing tube of insects.
20. A V-shaped cuticular plate supporting the elongated labium of a bee or a similar insect.
25. The hairs of insects formed by cuticle.
27. Destructive insects of crops, etc., are commonly called....
29. Name of the vector of protozoan which causes sleeping sickness.
30. The cells which, by division, give rise to oocytes and hence to ova.
31. A rapid and complete transformation from larval to an adult form.
32. Term for production of males and females parthenogenetically.

Down

1. Common term used for migratory grasshopper.
3. Outer layer skin of an insect, made of sclerotin which is impervious to water.
4. Generic name for human body louse.
5. Type of antenna present in housefly.
7. A part of an insect's wing forming a small separate lobe close to the body.
9. Abbreviation for a contact insecticide.
10. Family to which migratory grasshoppers, having shorter antennae, belong.
11. Male bee which develops by parthenogenesis.
12. A protective covering for the pupa of an insect.
13. When two squamae are present on the inner side of alula, the one nearest to the alula is known as ......
14. First segment of the insect's leg.
15. Name of a mimic butterfly.
16. The adult form of an insect after metamorphosis.
18. Name of order to which fastest flyers belong.
19. Group of insects which have wings.
21. Emergence of adult from pupa is also known as..........
22. The stage at which slowing down of metabolism and delay of development of insect takes place.
23. Generic name of 'Jowar' borer.
24. The fertile female in a colony of termites capable of laying eggs.
26. Type of image formed in the compound eye.
28. Young worker bee engaged in the feeding of larvae.

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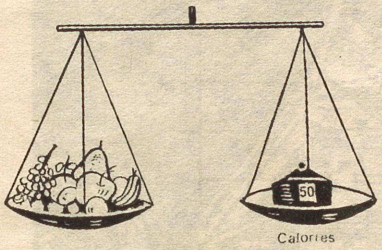
FOR HER

Lal sag

WHAT you call in Hindi *Lal sag* or *Chaulai sag* is botanically *Amaranthus gangeticus*. In Kannada, Telugu and Tamil it is respectively known as Dantu, Tola Kura and Mulai Keerai. There are in fact a total of 60 species of the genus *Amaranthus*, out of which 25 are grown in India. What is the nutritive value of this herb? Like other green, leafy vegetables it is rich in vitamin A and iron. Some of the much valued contents per 100 grams of this, vegetable are: vitamin A-9200 IU; Vitamin C-99 mg; iron 25.5 mg; calcium-397 mg. And undoubtely it is good for children, pregnant women and nursing mothers.

Caloric requirement

THE food we eat supplies energy required by us for physical and physiological processes such as cellular functions, heart beating, brain function, etc. The energy value of a food is assessed in terms



of calories. The caloric value of different foods is known. For example, some of the foods per 100 grams have caloric equivalent as follows: cereals and millets 360; pulses-350; vegetables-25 to 50; fruits 25 to 50; root vegetable and tubers-90 to 150; butter, ghee and oil-900; and milk, mutton and egg-60 to 180. By knowing caloric value of each of the food items, one can calculate a man's or woman's daily caloric requirements and balance the food accordingly. But, what are the caloric requirements of average Indians of different ages and sexes?

It is as follows:

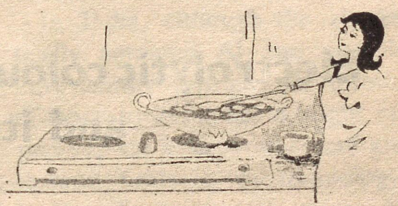
Man	
Sedentary work	2,400
Moderate work	2,800
Heavy work	3,900
Women	
Sedentary work	2,000
Moderate	2,300
Heavy	3,000
Pregnant	2,300
Nursing	2,700
Children	
0-6 months (per kg.)	120
7-12 months (per kg.)	100
1-3 years	1,200
3-6 years	1,500
6-9 years	1,800
10-12 years	2,100

Adolescents

13-15 years	.. Boys	2,500
16-19 years	.. Boys	3,150
13-15 years	.. Girls	2,100
16-19 years	.. Girls	2,100

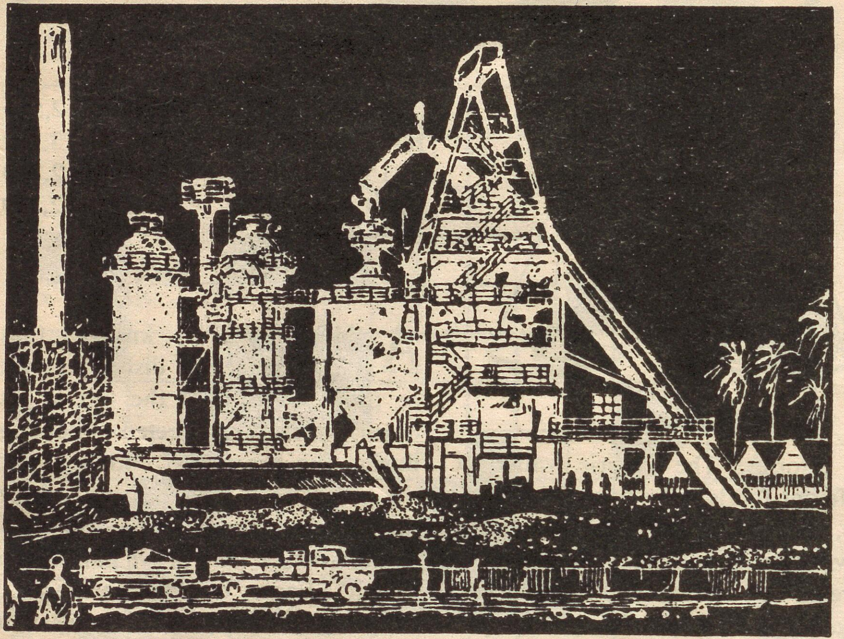
Fried foods

A HOUSEWIFE knows that several delicious dishes cannot be prepared without the use of fat or oil, which are subjected to heating during the process of cooking. But do you know that heating oil or fat brings about some chemical changes which may prove harmful to health? Some of the unsaturated fatty acids in most of our oils and fats are known to be essential for man. The unsaturated fatty acids, however, react with oxygen of the atmosphere and form oxidation products known as peroxides, many of which are injurious to health. The peroxides further decompose to form other compounds



which are equally injurious. Also, at a high temperature the molecules of fats, or oils join together to form complicated and larger molecules by the process of polymerization. For example, in the preparation of fried food such as *puris* the oil may get over heated and be polymerised. The polymerised oil is hard to digest, and it invariably leads to indigetion. Prolonged heating, high temprature and reuse of left-out oil are inadvisable and should be avoided while preparing fried-foods.

ZAKA IMAM



SCIENCE IN INDUSTRY

Electrolytic colouring of aluminium and its alloys

LESS than a century ago, aluminium was considered one of the rare metals. It was so precious that Napolean III of France considered it more prestigious to serve food in aluminium dishes instead of in gold dishes when entertaining the King of Siam in 1886. However, aluminium is now one of the most easily available metals, and takes its place next to steel in abundance. On account of the comparative corrosion resistance of aluminium, it is being increasingly used for decorative and architectural purposes. Specially, coloured aluminium articles are very much in demand for such uses.

There are two processes by which aluminium and its alloys can be given a coloured oxide film: (i) the anodized material is coloured by dipping in a suitable dye for sufficient time and under optimum conditions before sealing, and (ii) purely electrolytic processes by which the colour is developed either during the anodizing itself, or subsequently by electrodeposition of metal ions onto and into the film from various metal salt solutions. Either, A.C. or D.C. or a mixture of A.C. and D.C. can be used for either of these electrolytic anodizing, colouring processes.

Integral colour anodizing

Most of the integral coloured finishes are made with the following four processes:

(i) *Conventional sulphuric acid anodizing.* This process produces "clean" or "natural" coloured coatings on commercial aluminium, but on alloys containing Si and Cr. The colours produced are grey and yellow respectively.

(ii) *Hard-coat sulphuric acid anodizing.* This produces harder and more abrasion-resistant coatings than those produced by the conventional sulphuric acid method by using low temperatures and higher current densities. Colours produced are yellow, bronze, black, etc.

(iii) *Oxalic acid anodizing.* This is less common because of higher cost than sulphuric acid processes. The colours produced are also similar as those produced by the sulphuric acid processes.

(iv) *Organic sulphonic acid anodizing.* These processes are known under various trade names as "Kalcolour", "Duranodic", "Reynocolour", "Permalux", and "Autocolour HSH", etc. Excellent coatings as regards variety of colour, hardness, colour fastness and other desirable properties can be produced by this method with colours ranging from yellow, amber, bronze, gray to black (Table 1).

In the single step integral colour anodizing process, the production of different colours is possible with a proper combination of anodizing electrolytes and the compositions of materials to be anodized apart from various variable parameters.

The presence of alloying elements in excess of the permissible limit may result in undesirable effects during anodizing.

Out of the electrolytes mentioned above for integral colour anodizing, the organic sulphonic acid group alongwith Periodic Table group VI B anions specially molybdates and tungstate present a large variety of organic acids and compounds which serve to produce over and above the now familiar brown toned and black coatings—additional colours like blues, greens and grays with considerably less dependance on the basic alloy composition than in conventional sulphuric acid and oxalic acid processes. Several additions have been employed in the anodizing baths to obtain various colours and beneficial effects.

A list of aluminium and its alloys suitable for decorative, general purpose and architectural anodizing with the details of operating conditions in the conventional, and complexing and non-complexing type of electrolyte can be found in any good and up-to-date work on anodizing. Some of the typical compositions are as follows:—

Table 1

Alloy	*Primary element%*	*Oxalic acid*	*Sulphuric acid*
99.99 Al	Trace of iron	Pale straw	Clear transparent
1100	About 0.4 Fe, 0.4 Si	Pure grey gold	Silver grey
3003	1.25 Mn	Brown	Pale brown
5052	2.2 Mg, 0.2 Cr	Golden bronze	Silver light yellow
6063	0.7 Mg, 0.5 Si	Pale gold	Silver
6061	1.0 Mg, 0.6 Si 0.25 Cr, 0.25 Cu	Dark brown	Yellow
2014	4.0 Cu, 0.6 Mg, 0.5 Mn	Bluish white	Bluish yellow
5086	4.0 Mg, 0.5 Mn	Brownish yellow	Silver grey
4043	5.0 Si, 0.5 Fe	Grey Bronze	Gray

Anodizing and colouring by electrolysis

The process of colouring the anodized material by subsequent electrolysis is of a more recent origin. Recent literature on anodizing is flooded with patents on electrolytic colouring of anodized aluminium. The relative simplicity of the electrolytic colouring technique, the relatively inexpensive equipment required and the excellent properties obtained with these finishes has led to a rapid growth of interest in the process.

In this process, the anodized material is immersed in an electrolyte containing one or more of the salts of Cu, Sn, Co, Ni, Cr, Fe, Ag, Pb, or a manganate, tellurite or silenite. An alternating or direct current or superimposed on A.C. is used to effect the electrolysis resulting in coloured films such as gold, greyish blue, blue bronze, black, etc., which are then sealed in the usual way. By this method, very thin coatings can also be coloured to the same depth of colour as thick films.

The various colours obtained on aluminium and aluminium alloys enhance their use mostly decorative applications. Being a decorative civil engineering aspect of build ing, the coloured aluminium and its alloys have been extensively used in architecture especially as anodized colour aluminium is weather resistant, and is available at reasonable cost. Some of the most common applications in this field are: wall grids, panels, industrial roofing and siding, monumental residential and indusrial windows, shop fronts, office partitions store fronts, etc.

The uses of integral colour anodized and electrolytically coloured Al and Al-alloys have not yet been fully exploited in India, although in European countries the colour anodized products are being extensively used for a multitude of applications including decorative and architecutral.

Colour anodized Al and Al-alloy sheets can successfully and economically replace the galvanized iron and tin sheets as materials of construction for various purposes.

In India, although the elcctrolytically coloured Al and its alloys have hardly crossed the threshold of laboratories, it has a bright prospect for use in decorative and architectural fields as its technology is in the developmental stage. New and specialised techniques are being invented, as the need arises, enlarging the scope of the application of colour anodized aluminium products.

There is ample scope for its development for uses in various fields. The integral colour anodizing is a definite advancement in the technology of colour anodizing and it has made spectacular progress in a short time. The process of organic sulphonic acid anodizing for electrolytic colouring of aluminium and its alloys is a great achievement in this field as this has made

Table 2

Composition of Al and Al alloys	*Electrolyte and bath composition*	*Anodizing conditions*	*Colour and remarks*
KS45 (5005)	2. 6-dihydroxy benzoic acid + H_2SO_4	2, 4 A/dm^2 25° C, 30 min. 90 V max.	Black 5 mm thick
KS45 (5005) 6061, 1199	Ammonium para molybdate + H_2SO_4 +oxalic acid	2A/dm^2 , 25° C, time varied according to thickness desired, 70 V max.	Blue, dark-blue, green and black with non aq seal and brown to black with aq seal 0.6-1.4 mil.
Al or Al alloys (5005)	2.7% ammonium para molybdate 1.65% sodium tungstate + 0.5-8% H_2SO_4+ 0.5-4.5% oxalic acid	0.5-3A/dm^2 25° C, 90 min. 30-100 V max.	Dark blue colour unrelated to alloy composition
Cast alloy (Be 0.05-2% and Fe +Si 1%)	10% sulphosalicyclic acid + 0.5 H_2SO_4	300A/dm^3 20° C, 45 mins.	Amber
A-SGM (1% of Si, Mg, Mn) and others	5-20% sulphomaleic acid + 0.05-0.8% H_2SO_4	1-4A/dm^2 15-30° C, 30-60 min.	Light bronze to black films
KS 32 (1100)	3, 5-dihydroxy 4 carboxy toluene, 6-disulphonic acid+ H_2SO_4.	24A/ft^2, 25° C	Dark brown colour with Fe^{+3} deep red/blue

available to users a spectrum of colour products so appealing, economical, durable and easily within the reach of masses.

T.L. Sharma Y. N. Trehan
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NAL develops low-power wind electric generator

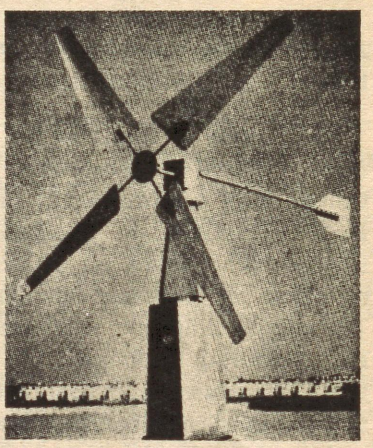
THE National Aeronautical Laboratory (NAL), Bangalore, has designed and developed a wind electric generator to serve as a source of electricity alternative to dry cells which are essential in operating isolated electronic system. As and when the wind energy is available the wind electric generator charges a long life battery from which the energy can be drawn.

The wind generator has been designed with emphasis on least maintenance and has the following features: (i) the blades are made of an aluminiuim alloy and resist corrosin; (ii) the blade assembly has a feathering mechanism to reduce the angle of attack for high wind speed; (iii) the head assembly is totally enclosed and the steel parts are painted with oven baked epoxy paint; and (iv) the electric generator is coupled such that slip rings and brushes are avoided.

The device is capable of producing better than 20-30 VAhr of energy on a wind day and is an economically viable alternative to the dry cell. Prototype tests are under way.

The specifications of the wind electric generator are:

Type	: MP 30
Propeller diam.	: 2 m
Number of blades	: 4
Rated speed of propeller	: 150 rpm
Rated wind speed	: 7m/s
Cut in wind speed	: 3.5 m/s
Rated power of generator	: 30W
Output of system	: 4V
Energy storagec apability of battery	: 24VAhr
Output energy on a typical windy day in Bangalore	: 20VAh



Low power wind electric generator developed by NAL, Bangalore

The generator will find application in aviation lighting on remote features, navigation buoys on seaways, repeater stations for telecom equipment, radio reporting rain gauge stations and similar automatic measuring systems, and power source for radios in isolated windy locations.

BOOK REVIEWS

COMPUTER POWER AND HUMAN REASON From Judgement to Calculation by Joseph Weizenbaum, *W. H. Freeman & Co.*, 660, Market Street San Francisco California, 94104 (U.S.A.) Pp. 300, $ 9.95

WHETHER you are a computer programmer thrilled by the efficiency or accuracy of computer, or you are a business administrator more so ever relying on computers for decision-making or production, or you are a man on the pavement day-dreaming that one day computer would do all your job while you take a nap, beware of the silly impression you might be carrying about computers, that they are getting more and more powerful and the day is not far away when they would replace human beings. This is what, in short, Joseph Weizenbaum, the author, tries to say in this book. Though like the title the book is erudite in content, the subject as complex as computer science has, however, been broken down into such bits as to be understandable to any one knowing elementary mathematics.

In the introduction the author, who is a Professor of a Computer Science at M.I.T., Massachussetts, tells how he was inspired to write this humanistic book. It started off when he made the computer, chrisened ELIZA, which could respond to people within a limited language vocabulary. As the computer used to respond by taking hint from the things said to it, it soon attracted notice as a psychotherapy tool. That ELIZA could replace psychotherapists in curing mental ailments became a popular belief overnight. No time was lost then by computer scientists to declare with more vehemence, though the belief had already been in circulation for more than a decade, that computer would one day replace engineers, doctors, artists, etc., and eventually the man himself.

The author was overwhelmed by such statements and to argue himself out he wrote this book, saying with all the force that computer could never replace human beings. In about 280 pages, he uses all his experience with computers and people to drill into one's mind this seemingly inevitable belief. He weighs the significance of computer in all perspectives such as moral, ethical, social, emotional, etc. To prop up his arguments he quotes various authorities and discusses the pros and cons of the said things.

While in the first nine chapters, the author drives home his views as to what computer can do and cannot do with his lucid and powerful expression, in the last chapter he makes a sort of appeal to computer programmers and technologists not to put computer to destructive uses. From the recent events, such as Vietnam war, etc., discussed in it, one gets the impression that the rise of computer is the downfall of human race.

The book, to be frank, would be of interest to those who harbour a love for philosophy not necessarily science-interested intelligentsia.

DILIP M. SALWI

GENETICS AND BIOCHEMISTRY OF PSEUDOMONAS Edited by P.H. Clarke and M.H. *Richmond, John Wiley and Sons* pp. 366, $39.95; *Indian Representative* : Wiley Eastern Bookshop, 4654/21, Daryaganj New Delhi 110002

THE bacteria belonging to the group Pseudomonas are of considerable scientific and practical importance with respect to human pathogenesis and indusrial microbiology. The above book has been produced with the cooperation of nine contributors and their effort seems to be impressive. The fields covered are microbiology, medical aspects, genetics, biochemistry and molecular biology. *E. coli* is the only bacterium which has been studied very extensively; and when other bacteria are studied, *E. coli* is used for comparison. The organization of genetic material of the bacteria is discussed in detail here and a comparison is given with the arrangement of genes on the chromosome with that of *E. coli.* Studies with a number of Pseudomonas species have provided valuable contributions to the understanding of biochemical pathways and this has been dealt well. Those interested in plasmids will find this book very informative.

The last chapter discusses the possibilities of fundamental contributions which this organism can make on molecular biology together with solving problems like biodegradation of organic molecules introduced into natural environment by man. It is only during the last few years that scientists have focussed attention on this group of bacteria and the information compiled here will be useful to advanced students and research workers in microbiology.

The layout of the book is pleasing; the informations is presented well with a factual approach. The bibliography at the end of each chapter is useful and the index satisfactory.

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MODERN IMMUNOLOGY by A. Dasgupta, 1976 Edition, *Tata McGraw-Hill Publishing Company Ltd.*, Asaf Ali Road, New Delhi-1 Pp. XII+318, Price : Rs. 21.00.

ALTHOUGH there are many books on immunology—both basic and applied—written by experts the world over, the book under review is the first comprehensive book written by an Indian author on the subject. The author is associated with the subject at the Department of Microbiology, All India Institute of Medical Sciences, New Delhi.

The tissues and cells capable of exhibiting what is now recognized as an adaptive immune response have an evolutionary history of some 400 million years. The meaning of the term immunity, as it is used today is derived from its earlier usage meaning exemption from military service or paying taxes. Immunology as a science began with the demonstration in 1890 by von Behring and Kitasato at the Koch Institute in Berlin, of an antibacterial substance or factor in the blood, now known as antibody globulin, of animals immunized against tetanus and diphtheria organisms.

The book has been divided into eleven chapters starting with a historical background of this branch of science. In England, the procedure of cow-pox vaccination developed by Edward Jenner in 1798 for protection against smallpox and that used by Francis Home in Edinburgh for measles protection were essentially empirical measures performed without understanding the underlying principles. The discovery of the tubercle bacillus by Robert Koch led him to describe the phenomenon of delayed hypersensitivity or cell-mediated immunity as it is known today.The principles underlying the above phenomena are described clearly and systematically in the next four chapters on the process of immunological response and interaction between antigen and antibody. The following chapters describe the role of immunology as used in health and disease, These describe in a simple manner the understanding of immunological processes underlying the reaction of the body to tumors, to transplanted tissues and organs, and to infectious agents. It provides various laboratory techniques on preparation of lymphocytes, distinction between T - and B - cells, and *in vitro* tests used to demonstrate antibody production and cell-mediated immunity. Each chapter is further made more understandable by providing diagrams and tables. It has an excellent further reading references covering literature upto 1975 at the end of each chapter. It has also a number of black and white plates showing antigen-antibody complex, macrophage, T-and B-cells, macrophage migration inhibition test, lymphoblast, etc.

It is written in a simple language and is sufficiently broad in scope and fundamentals to give the students of medicine a firm foundation before proceeding to a more advanced work in the field.

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GENETICS by P.S. Verma and V.K. Agarwal, *S. Chand and Co.*, Ram Nagar, New Delhi-110055. Rs. 11.00.

THE science of genetics has gone a long way since the days of Gregor Mendel. After Watson and Crick came out with the structure of DNA and RNA in 1962, it became apparent that man could, sometime in the future, tamper with the basic nature of all living beings including his own species.

Also, an understanding of the biochemical basis of heredity would enable biologists to study the processes of growth and reproduction. No wonder then, that genetics has emerged as a major discipline and has been introduced at the undergraduate and the post-graduate levels for students of biology. This book is one of the first Indian textbooks to appear on the subject. Perhaps that is why the book covers a wide range of the subject—starting with the elementary concepts about the laws of inheritance and gradually going into the biochemical complexities at the molecular level. Beginning with Mendel's experiments, it goes on to discuss at length, the nature of gene action. Being accompanied as it is, with rather expressive diagrams and elaborate examples to illustarate all basic principles, it would be a good textbook for B.Sc. (General), B.Sc. (Hons), B.Sc. (Agriculture) and even M.Sc. students. Teachers at the Higher Secodary level, who probably never had genetics in their syllabi, would find it of great value. The book is reasonably priced.

RATNABALI MITRA
20, *Mukherji Nagar (West) Delhi-110009.*

CYTOGENETICS, PLANTBREEDING AND EVOLUTION by U. Sinha and Sunita Sinha, *Vikas Publishing House Pvt. Ltd.*, 5, Ansari Road, New Delhi-110002, 1976, Pp. 396, Rs. 22.00.

MANY new books dealing with different science subjects are appearing in the Indian market. Some of these books contain material copied from foreign books, while others contain material modified from the original. The latter books, instead of being made easy to understand, are made more confusing by the authors because of their lack of understanding of the subject and lack of expression. The book under review, however, is free from any of the above mentioned defects, as it has been written by two persons who have the clear background of the subject owing to their research and teaching experience.

This book is a store of information for graduate and post-graduate students of agriculture, anthropology, botany and zoology. It contains in a single volume the classical and the modern works in the field of cytogenetics, plant breeding and evolution. The book is well illustrated by means of photographic plates and self explanatory diagrams. The reproduction of the photographs, however, is poor and there are many typographical errors. The authors have divided the book into 21 chapters and devoted 9-18 page to each chapter. They have explained in a lucid language and in a coherent and interesting manner the different topics in each chapter. Apart from these informative chapters there are some model genetical problems, a supplementary reading list spread over 14 pages and an index of 18 pages.

In this book, the students can find topics that were so far found in books dealing with molecular genetics and biochemistry. Recent additions to our knowledge of genetics at molecular level such as Meselson and Stahl's experiment on DNA replication, transcription, genetic code and codon assignment in amino acid synthesis and Taylor's experiment showing semi-conservative replication of the chromosomes are also dealt with in the book, thus saving the trouble of consulting other books.

The book also enlightens us on the changing concept of the gene since the time of Mendel. The experiments of Beadle and Tatum demonstrating 'one gene-one enzyme' theory and those of Yanofsky et al., regarding one cistron-one polypeptide' and the colinearity of the gene and the polypeptide are some new aspects in genetics given in this book. The breeding and improvement of some crop plants such as rice, wheat, maize, sugarcane and potato form one of its chapters.

The authors have made a passing reference to parasexuality and the possibility of protoplast fusion as an aid in hybridisation of animals and plants. These topics could have been elaborated further since plenty of work has been done in these fields. The book in general is highly useful for graduate and post-graduate students, but is out of reach of many because of its high price even though it is printed on subsidised paper.

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BOOKS RECEIVED

1. **QUANTUM MECHANICS** (2nd Edn.) by A. S. Davydov, *Pergamon Press*, Headington Hill Hall, Oxford OX3 OBW, England, Pp. $ 636,

2. **PHYSICS IN INDUSTRY** Ed. by E.O. Mongain & C.P. O'Toole, *Pergamon Press*, Headington Hill Hall, Oxford OX3 OBW, England, Pp. 595, $ 30.00

3. **GRAVITATION AND RELATIVITY** by M.G. Bowler, *Pergamon Press*, Headington Hill Hall, Oxford, OX3 OEW, England, Pp. 172, $ 14.50

4. **INTRODUCTION TO GENERAL RELATIVITY** by H.A. Atwater, *Pergamon Press*, Headington Hill Hall, Oxford, OX3 OBW, England, Pp. 221, $ 13.00

5. **HANDBOOK OF THICK FILM TECHNOLOGY** by P.J. Holmes and R.G. Loas by *Electrochemical Publications Ltd.*, 29, Barns Street, Ayr., Scotland KA7 1XB, England, Pp. 430, $ 57.50

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

7. **B.Sc. PROBLEMS IN PHYSICS** by Dhar, Sehgal and Chopra., *Sultan Chand & Sons*, 4792/23, Daryaganj, N. Delhi-110002.

8. **DO IT YOURSELF RADIO** by Bhavnani, *Hind Pocket Books* Rs. 5.00

9. **ENGLISH FOR TECHNICAL STUDENTS** by R. Sundasanam, *Tamil Nadu Agricultural University.*, Agricultural College and Research Institute, Coimbatore-641003, Books I, II, III, Pp. 138, Pp. 152. Pp. 154, Price not indicated.

10, **OBJECTIVE TYPE NUMERICAL PROBLEMS IN PHYSICS AND CHEMISTRY** by M. N. Verma and A. Yadav, *R. P. Shrivastava & Sons*, Kazipur, Patna-800004, Pp. 308, Rs. 20.00

Registered with Registrar of Newspapers : R.N.7440/64

Printed and Published by S. P. Ambasta, Council of Scientific and Industrial Research, Rafi Marg, New Delhi-110001 at the Delhi Press, Jhandewalan Extn., New Delhi-110055

Regd. No. D-(C)-66.