

Book Reviews

Beyond natural selection by Robert Wesson. The MIT Press, 55, Hayward Street, Cambridge, MA 02142, USA, 1991, pp 376, \$29.95.

Human beings are not simply the result of mechanistic forces. In this treatise, Robert Wesson, a political scientist turned natural philosopher, attempts to provide an alternative approach to evolution. He believes that the orthodox account of evolution in terms of natural selection of random genetic variation is inadequate, and must incorporate such concepts as self-organisation, the autonomy of the genome, and the inherent tendency of organisms to evolve greater complexity. He points out the Darwinism and neo-Darwinism can not only explain just a part of the richness of contemporary life forms, but also fail to explain the evolution of complex systems such as the human eye, the sonar apparatus of bats, and the electric organs of some fish. These are infused with patterns apparently better described by the methods of modern chaos theory. Wesson begins his book with a description of Darwinian theory but tries to show how and why natural selection cannot sufficiently account for the multitude of modern species. To support his view, he brings in, along the way, a series of familiar arguments: the inadequacy of reductionism, the gaps in fossil record, selectively neutral variation and the persistence of apparently maladaptive characters. He concludes his study by applying evolutionary theory to humans, finally discussing the relationship between the way we understand evolution and the development of human values.

But how good are Wesson's arguments? Although his account is peppered with interesting facts drawn from natural history and the even more interesting aberrations that defy natural selection, on the whole, the book fails to convey its apparent message. The author reveals his understanding of recent research only in patches but, more important, fails to offer anything concretely new or better by way of explanation of these phenomena. His discussion on sex is a case in point. Although this chapter contains fascinating information, there is no mention of any of the new ideas in this field. There is no reference to the thinking of Williams, Maynard Smith, Kondrashov or Hamilton. He does not discuss the recent debate about the role of parasites in the evolution of sex and in sexual selection. He even glaringly claims a failure to understand why inbreeding should necessarily be harmful, glossing over the homozygosity of deleterious recessives as a universally accepted cause of inbreeding depression. There are many such oversights. Finally, he lamely suggests, rather unconvincingly, "one must look for non-Darwinian factors", but also fails to come up with any!

This is, in fact, the most important drawback of this book. Although Wesson outlines a number of concepts such as self-organisation and the autonomy of the genome, he fails to apply them coherently to the problems at hand. We are thus left with a strong feeling that all the acknowledged complexity of living processes are simply being called by some other names. These concepts do not thus improve in any way our understanding of the bases of these processes. He also appears to wish away complexity repeatedly by assuming that all things have an inherent tendency to become complex.

Although their views are open to debate, Wesson seems to have missed the points made by the reductionists like Dawkins and Wilson completely. He thus expresses his surprise that "... the function of the elephant, a complex, seemingly purposeful, and responsive creature, or of a human is to copy sequences of nucleic acid bases, which can do nothing outside the body and are of no significance except as they contribute to the making of a new elephant or a new person". On this, as on many other occasions, Wesson invokes spirituality as a possible underlying factor characterising life. He appears to be too involved with 'the emptiness of humanity', 'an indifferent universe', etc., in the light of the richness of nature and human achievement. This is not a new feeling, nor an unusual one. But where does it stand in the harsh glare of modern empirical science? He rules out evolution as a wholly mechanistic process

by invoking a spiritual component in human beings. But how can he justify such an argument? Is not the battle to understand evolution lost if one ultimately takes recourse to such mysticism?

One must admit, however, that lurking amongst these beliefs is a very interesting idea, one that deserves due thought and consideration. And that is: if there are organisms, such as us, who are able to think about their origins, then whatever was necessary for their evolution must necessarily be true, however, unlikely. Although one detects a logical base to this argument, accepting it would again be tantamount to foregoing our attempts to understand the mechanistic basis of evolution.

A word of caution. Wesson seems to believe, as I have hinted earlier, that it may be dangerous for our civilisation to accept the view that "... humanity is the insignificant by-product of random change selected by chance and material conditions..." He counters that "if one consistently adhered to the Darwinist canon, the logical social ethic... would be to join with genetically kindred persons to get the better, reproductively, of all others, ultimately to replace them by whatever means available." In the light of this worry of Wesson's, is it not more dangerous to believe that man is more uniquely favoured by evolution? Because if we do so, by an extension of the same line of reasoning, we run an even greater risk of practising exactly what Wesson is so afraid of. And because he believes that man is not inherently selfish, Wesson suggests that Darwin was wrong. In conclusion, we can only remember Monod who pointed out that we cannot derive our values from science. We can only do science if we come to it with some prior values, foremost amongst them a respect for truth.

National Centre for Biological Sciences
TIFR Centre
Bangalore 560 012.

ANINDYA SINHA

Biodegradable polymers as drug delivery systems by Marck Chasin and Robert Langer. Marcel Dekker, Inc., 270, Madison Avenue, New York, NY 10016, USA, 1990, pp 368, \$ 119.50.

Indiscriminate drug action and the failure of drugs to reach the diseased cell can often have devastating consequences in therapeutic medicine. The long-term challenge is, of course, to develop more selective chemotherapeutic agents for the lasting treatment of diseases. Since the development of new and more selective therapeutic agents is very expensive, time consuming and often uncertain, emphasis is now being laid on the design of drug-delivery systems that target existing non-selective drugs to the affected areas preferentially thereby imparting them with an exquisite target specificity and improved efficacy. There are two principle approaches for the targeting of drugs. In the first, one encapsulates the drug into the lipid vesicles, the liposomes, which act as vehicles for delivering it to the affected area. In the second, one attaches chemotherapeutic agents to proteins capable of interacting with a particular type of tissue for transporting the drug to that tissue alone. In both the approaches a non-selective drug is localized into a particular part of the body by the tissue specificity of the carrier molecule endowing the former with target selectivity. Critical to the development of optimized drug-delivery systems is the design of target-specific carriers. Attachment of ligands such as sugars, hormones and antibodies endows the carrier with target specificity. On the other hand, attachment of drugs to hormones, antibodies, etc., promotes their localization in the organs for which these proteins are known to be specific.

An important and desired attribute of a carrier for delivering pharmaceutical and agricultural agents is their biodegradability. This is easily achieved for liposomal delivery system as they are natural constituents of membranes and are devoid of adverse side effects encountered with non-degradable polymeric counterparts and are mostly non-immunogenic. However, they suffer from the disadvantage of having a short shelf-life and lifespan in biological milieu. Hence, during the recent years the emphasis has shifted to the design of biodegradable polymer for the site-specific or systemic delivery of drugs, pesticides, etc., which would subsequently not require the retrieval of the delivery system. Other expected notable applications

of such polymers are the design of biodegradable sutures, bone plates, etc., and even artificial organ replacement implants. This book is very welcome in this context.

The book consists of eight chapters. Each chapter begins with a comprehensive introduction followed by synthesis, polymer characteristics, biodegradation, release kinetics of the encapsulated molecules, fabrication and sterilization techniques and the analyses of the efficacy of the delivery of small and large molecular weight bioactive molecules and ends with a precise summary of a particular polymer system. Thus, polymers of lactide/glycolide, polyanhydride, poly- ϵ -caprolactone, poly (orthoesters), polyphosphazenes, pseudopoly (amino acids), natural polymers and liposomal systems are discussed successively in each of these chapters.

Biodegradable polymers as drug delivery systems by Chasin and Langer can be welcomed as a bold and on the whole successful attempt to integrate synthesis, structure and application of biodegradable polymers. The individual chapters provide balanced survey of this rapidly growing field. Basic concepts and experimental approaches are clearly explained so that the general level is suitable not only for the advanced student but also for the researchers who want to keep in touch with the progress in the field. And it provides worthwhile insights on the harnessing of polymer chemistry for applications in biomedical fields, a partnership whose agenda is bound to grow. This concise and readable introduction should appeal to a wide audience.

Molecular Biophysics Unit
Indian Institute of Science
Bangalore 560 012.

A. SUROLIA

Membrane fusion by Jan Wilschut and Dick Hoekstra. Marcel Dekker, Inc., 270, Madison Avenue, New York, NY 10016, USA, 1991, pp 930, \$ 234.

Like in any field of human endeavour in science as well some areas are considered more fashionable than others at any given time. Studies on nucleic acid, for example, have held total sway for many decades. But as knowledge expands frontiers change. Today all eyes are no longer focussed on nucleus and nucleic acids, cell membrane is the new frontier. This is least surprising considering that evolution of membranes preceded the advent of complex multicellular organisms and the fact that they define the boundaries of cell and cellular organelles and provide the framework and milieu for the occurrence of plethora of biological processes. Thus, cell plasma membrane is the locus for specific receptors, transport mechanisms and a variety of signal-transducing elements and enzymes that are essential for cell-cell recognition and communication, immunological response, memory, etc. The intracellular membranes such as those of mitochondria and chloroplast, on the other hand, provide the loci for the production of high-energy compounds while the membranous system of endoplasmic reticulum keeps on churning proteins and lipids, while still others, viz., that of golgi post-translationally modify newly synthesized proteins and lipids and channel their import to the plasma membrane and other intercellular compartments or the cellular surroundings or their import within the cell.

Despite the early realization of the importance of these phenomena the sluggish progress in this area can be attributed both to the apparent underlying simplicity of membrane organization and the difficulty of isolating the membrane components in homogeneous form and their reconstitution in vectorially relevant form.

Though cell membranes are essential for maintaining the identity of cells and their organelles both at morphological and physiological level, many cellular and developmental processes require fusion of otherwise incompatible opposing membranes in a spatially and temporally controlled manner. The fusion familiar to all biologists, the fusion of a sperm cell with an egg that results in fertilization itself is so exquisitely controlled that once the event (fusion) has occurred it would not be repeated by drones of newly arriving sperm cells. But nature has invented many processes that require continuous yet spatially and temporally

controlled fusion of membranes. These include endocytosis, secretion, membrane recycling and so on. One of the strengths of this expensive yet highly readable book is that it is treated in the context of the general principles of membrane fusion to membrane structure.

Another strength of the book is that information from the various approaches to membrane fusion is well integrated. Results from biochemical and biophysical approaches are all combined with the necessary theoretical perspectives. Appropriate amounts of cell and molecular biological approaches are also highlighted in sections dealing with intracellular membrane traffic.

Membrane fusion is divided into six sections, subdivided into various chapters, each deliberating on a particular topic. Part I contains three chapters on membrane structure, lipid polymorphism and forces stabilizing lipid assemblies in membranes which are meant as a general introduction on the subject. Part II pertains to the description of mechanism of membrane fusion in molecular terms in model systems. Part III covers the membrane fusion mediated by enveloped viruses which illustrate best the molecular basis of fusion in natural membrane systems. Part IV treats the burgeoning field of the molecular dissection of endocytosis and exocytosis in reconstituted cell systems. Cell-cell fusion events, *viz.*, exoplasmic fusion typified by the fusion of myoblast and sperm-egg fusion are dealt in Part V. Part VI describes the applications of membrane fusion techniques in cell biology, medicine and biotechnology and discusses such diverse topics as tools for the study of cell-cell fusion hybridoma techniques to the introduction of genes into the cells, etc.

Each chapter begins with an overview of the subject and subsequent treatment of it ranges from an original article to a review complete with a reference listing. None the less each chapter is authoritatively written and is rich in scientific content.

Although the book is clearly organized and provides a coherent treatment of the subject, one need not read it straight through. The various parts, depending on the level of sophistication the reader brings to the material, be read independently and out of order, and each of the chapters treating a specific facet of membrane fusion constitutes a thorough, interdisciplinary free-standing review of that aspect. In summary, the book is the best one-volume survey of this complex subject, and deserves wide use in biochemistry, cell and membrane biology as well as in medicine and biotechnology courses and research with the only rider being its exorbitant price (\$234) which I believe only a few individuals can afford.

Molecular Biophysics Unit
Indian Institute of Science
Bangalore 560 012.

A. SUROLIA

Nervous systems: principles of design and function by R. Naresh Singh, Wiley Eastern Limited, 4835/24, Ansari Road, Daryaganj, New Delhi 110 002, 1992, pp 506, Rs. 500.

The book is based on an international conference with the theme similar to the title that took place in Goa in December 1991. It is a *pot pourri* of conference reports solicited from a cross section of established groups working on diverse aspects of neurobiology. A wide spectrum of experimental systems such as worms, insects, crustaceans, fish, bats, rats and humans with different approaches such as molecular biology, histochemistry, morphometry, electrophysiology and theoretical modelling are represented. The bulk of the contribution is however *Drosophila* neurobiology based.

The contents are broadly classified under Molecular and genetic approaches to the nervous system, Organization and development of the nervous system, Information processing in the visual system, Auditory and chemosensory system, and the manuscripts which arrived late interestingly classified separately as late arrivals.

It is my impression that the editor probably attempted to bring people actively working in neurobiology

in the country together, offer them a common forum for discussion, give it an international touch as well as an opportunity for interaction with neurobiologists outside India. I am not sure whether he succeeded in this because there are other small relatively young groups in the country whose work is not represented here.

The section on Molecular and genetic approaches to the nervous system has articles on aspects of genetic information required for the development of the adult nervous system of *Drosophila*. In this section I found the article by Balakrishnan and Rodrigues of particular interest, wherein they show by electrophysiological studies that mutations in the shaker locus do not affect the firing frequency of labellar chemosensory neurons to sugars and salts, although this results in distinct behavioural defects, which suggests that A-type potassium channels are not involved in taste transduction, and the neural basis of the defect could be at a higher level in the taste pathway.

In the section on the Organization and development of the nervous system, I particularly found the articles on development of dentate nucleus (Bijlani, Hayaran and Wadhwa) and quantitative assessment of the developmental profile of lateral geniculate nucleus (a relay station in the visual pathway) synapses (Wadhwa, Khan and Bijlani) of human foetal brain of interest. Human foetuses ranging in age from 13-14 to 34-35 weeks of gestation were used in the study.

The section on information processing in the visual system has an interesting article by Gewecke and Hou on the structure and function of visual interneurons in the locus brain, using a combination of intracellular recording and staining with lucifer yellow to monitor changes in activity of neurons in the protocerebrum to different visual stimuli consisting of different black and white, moving and stationary patterns. They have identified two groups of neurons with different extensions of dendritic arborizations in the optic lobe, of which the group with dendritic arborization within the most proximal lobe, the lobula, was partly directionally movement-sensitive. They suggest that this group may be important in the visual pathways involved in flight control. Their study also goes on to show that cellular modules with respective functions are an inherent component of the central nervous system design in their arthropod model.

Irvine, Rajan and Robertson in their paper under the section on Auditory and chemosensory systems discuss an important aspect of plasticity *vis-a-vis* reorganization of the auditory cortex following lesions in the cochlea. This study has relevance to many forms of partial deafness produced by exposure to loud sounds or ototoxic agent which involves damage to restricted region of cochlea.

The only theoretical modelling paper in the book is by Kowtha, wherein he discusses the modelling of the spontaneous firing in squid axons. The paper however has some lapses in that the numerical method, the experimental data on which modelling is based and the form of the bias current are not adequately discussed. In this paper most of the references are missing and there is a mismatch between the text and figures.

I have not mentioned the contents of all sections of the book. The selection I have commented on is partly biased by my own understanding and experience of certain areas of neurobiology. Most of the sections include well illustrated and well presented original material. Some of the articles under the section on late arrivals do not fall into any of the major classified sections of the book. This is probably to be expected of publications originating from a conference with a general and broad-based theme. The book however does give a flavour of the current approaches in neurobiology research. I think this book should be accessible to laboratories and institutions pursuing neurobiology research in the country, especially to students.

Molecular Biophysics Unit
Indian Institute of Science
Bangalore 560 012.

S. K. SIKDAR

Macronutrients by Marc S. Micozzi and Thomas E. Moon, Marcel Dekker, Inc., 270, Madison Avenue, New York 10016, 1992, pp 477, \$178.25.

The vast epidemiological information available on the role of macronutrients and their effects on the

development of cancers has been condensed in the form of this textbook. Four main topics, namely, (a) The role of macronutrients in cancer, (b) Methods for such investigations, (c) Evidence for specific macronutrients and related factors, and (d) Clinical trials on macronutrients and cancer, are covered in it.

(a) Studies on the correlation between nutritional elements and cancer have been reported for 40 years. Earlier studies dealt with only associations discovered in different populations. In recent years, this has been evolved to include metabolic and biochemical epidemiology which together with animal experimental models provides an understanding of the role of specific dietary risk factors.

The papers in the first part have been contributed by three authors. J. H. Weisburger discusses select aspects of nutritional mechanism as a basis for cancer prevention. The article includes high and low risk factors in relation to cancer of the colon, breast, endometrium, prostate, pancreas, stomach and esophagus. Of importance in this discussion is the analysis of the correlation of different sources of fat uptake. The effect of environmental factors on cancer incidence and mortality has been investigated during the last decade. These suggest that environmental, rather than genetic factors, play an important role in the etiology of several types of cancers. B. S. Reddy provides an overview of the results generated in the laboratory animal models on the relation between macronutrients like fat, protein, total calories and fibre and development of cancer. The effect of the type and amount of dietary fat during various stages of carcinogenesis with emphasis on cancer of breast and pancreas are some of the important points of this article. J. D. Potter discusses the maladaptation by humans to changing dietary pattern which results in imbalance in energy intake and output leading to specific deficiencies of potentially protective substances which in turn give rise to diseases such as cancer.

(b) The focus of the second part is on methods for investigating the role of macronutrients. There are four contributors.

Hartman and Block describe the methods employed for dietary assessment studies, their validity and limitations. They provide the rationale for such studies and discuss the impact that possible errors may have and the adjustments that can be made using statistical methods. J. T. Dwyer assessed the energy intake and expenditure which appear to have different influences on the risk of developing certain cancers. The purpose and methods of such studies are discussed. M. Micozzi in his paper on anthropometry and dietary assessment in nutrition and cancer reviews the scope of 'this study' in relation to cancer risks, especially in the light of limitations that nutritional assessments may suffer from. There is a discussion on the reliability and the overall applicability of such studies. A. R. Giuliano and T. E. Moon review biomarkers of macronutrients. The various available methods to quantitate dietary intake have not been fully successful and have weaknesses. These contribute to inconsistencies in evaluating the role of diet and cancer. Because of these reasons, biochemical markers are receiving more attention as independent quantitative measures of intake, digestion, absorption and metabolic breakdown. A few reported studies using biomarkers, e.g., metabolic breakdown of lipids, are discussed.

(c) The third part of the book comprises experimental evidences that relate specific macronutrients and related factors with cancers. Several factors which have been listed under high risk factors for cancers have been examined by seven contributors.

D. Albanes provides evidence for calorie intake and cancer. Though the evidence for low-calorie intake is directly correlated to cancer incidence, human observational studies provide a positive energy intake-cancer association. Of all dietary factors, dietary fat has attracted most interest by epidemiological studies and by animal experimental models. A. B. Miller reviews this aspect. R. A. Hiatt presents evidence for the association of different levels of alcohol consumption with specific human cancers, e.g., larynx, esophagus, stomach, pancreas, breast. Several issues like measurement of alcohol intake, the interaction of alcohol with other putative agents such as tobacco and proposed biological mechanisms are also discussed.

Serum albumin has long been used to assess protein-caloric nutritional status. Studies of the relationship between serum albumin and subsequent risks of cancer are consistent in showing that low albumin plays an estrogenic role in cancer development. R. S. Stevens and B. S. Blunberg review the inverse relationship between serum albumin and incidence of cancers. Dietary fibre is recognised as an important component of our daily diet. E. Lanza, S. Shankar and B. Trock review the evidence for the role of a fiber-rich diet

in the prevention of certain types of cancers—of the colon, breast, ovarian and prostatic. The article includes definition of dietary fiber, its analysis and consumption and mechanism by which fiber may affect cancer risk. Epidemiological investigations have shown international variations in cancer incidence. Risk differences among ethnic groups within the same geographical area support the hypothesis that cultural characteristics are more important than the total environment. L. Le Marchand reviews the epidemiological evidence for an association of body size with cancers of endometrium, breast, colon, prostate and kidney. Despite the long history of experimental and epidemiological research in cancer, the data relating to macronutrients to cancer risks is not consistent. D. Kritchevsky reviews the role of fats, carotenoid, Vitamin E and fiber.

(d) The last part of the book on clinical trials on macronutrients and cancer includes five papers contributed by R. L. Prentice, R. R. Love, P. A. Vargas, D. S. Albert, L. N. Kolonel, A. M. Y. Nomura, B. K. Rimer and P. F. Engstrom.

Clinical trials have been conducted over the past one decade to determine the relationship between incidence of certain cancers with introduction of low risk factors such as low fat as well as supplementation with preventive macronutrients and micronutrients. Topics of discussion in this heading are studies relating to lowering of incidence of breast and colon cancers. Effect of dietary supplementation with dietary fibre, Vitamins D and A are also reviewed. The importance of such clinical trials and the various strategies employed to derive conclusions are discussed.

The book gives an overview of information available on the epidemiological and related studies carried out on the relationship between dietary macronutrients and the incidence of certain cancers. Apart from this, there is added information on biochemical parameters to supplement 'associations' observed between the disease and high risk factors. The study also extends to animal model systems to lend proof.

Apart from providing vast information, the book makes good reading and I recommend it.

Department of Biochemistry
Indian Institute of Science
Bangalore 560 012.

ANJALI A. KARANDE

The essentials of viruses, vectors and plant diseases by A. N. Basu and B. K. Giri, Wiley Eastern Limited, 4835/24, Ansari Road, Daryaganj, New Delhi 110 002, 1993, pp 242, Rs. 400.

The essentials of viruses, vectors and plant diseases is a volume prepared for use in graduate and post-graduate courses in plant virology. Although the first plant virus was discovered nearly a century ago, the precise nature of viruses could be elucidated only in the 50s after the development of methodology for the purification and characterization of proteins and nucleic acids. Many detailed studies on the protein, nucleic acid components of viruses, *in vitro* translation, interaction with the host, assembly and structure were conducted in 60s and 70s. Recently, the techniques of molecular biology are increasingly used for understanding the life cycle of viruses. The book by Basu and Giri covers a significant portion of these developments. Not all these aspects of research are being pursued in laboratories of our country due to inevitable limitations. The authors of this book are intimately familiar with the activities in the country and accordingly have selected topics on the basis of local relevance rather than international development. They discuss in detail the techniques used in virus-vector relationship studies, the viruses that are found to infect different crops of the country, virus ecology and methods found useful in the management of viral diseases in India. The training and expertise of the authors is also noticeable in the detailed description of the insect vectors responsible for spread of viral diseases. In contrast, the chemical nature of viruses, host-virus interactions, isolation, characterization and identification of plant viruses receive only scant attention.

The book is a valuable addition to the literature on plant viruses. However, there is considerable scope for improvement of language and style of presentation.

Department of Biochemistry
Indian Institute of Science
Bangalore 560 012.

H. S. SAVITHRI

1729 Teel

INSTRUCTIONS TO AUTHORS

MANUSCRIPTS should be in English and written in a concise form. Three type-written double-spaced copies with one set of original Indian ink drawings and two sets of prints are to be submitted. The pages should be consecutively numbered and securely fastened.

TITLE PAGE should contain the following: (i) a brief title with suitable words for indexing; (ii) the names of the authors and the institution(s) where the work was carried out; (iii) a footnote with the present address of the authors, if different from (ii); (iv) a 75-word Abstract which summarises the significant results of the communicated paper; (v) key words for indexing and information retrieval; (vi) major discipline; and (vii) a running/short title.

TEXT should begin on page 2. It is preferable to break up the text into different sections, with suitable numbered headings, such as: 1. Introduction, 2. Experimental arrangement, 3. Theoretical analysis . . . , and 7. Conclusions. Acknowledgements should appear at the end of the paper, but before references.

REFERENCES should be indicated by Indian/Arabic numerals with superscript letters, e.g., "Earlier Bose⁶ has measured . . .". References should be typed in double space on a separate sheet in the order of their occurrence in the text and appended at the end of the paper. They should be given with full details as in the following examples:

- | | |
|--|---|
| 3. RAMAKRISHNA NAIDU, G.
AND NAIDU, P. R. | Isotopic exchange study of nickel xanthate in the presence of toluidines,
<i>Proc. Indian Acad. Sci. A</i> , 1978, 87 , 443-446. |
| 8. HINGDON, A. | <i>Engineering mechanics</i> , 1968, Vol. 1, Ch. 3, pp 79-104, Prentice-Hall. |
| 9. RAMA MURTHY, K. | <i>Convergence of state distributions in multi-type Bellman-Harris and Crump-Mode-Jagers branching processes</i> , Ph.D. Thesis, Indian Institute of Science, Bangalore, India, 1978. |

LENGTH of papers: Up to 25 pages (about 8,000 words) for full papers and 6 pages (2,000 words) for short communications.

TABLES should be included only when considered essential. They should be numbered consecutively with Roman numerals and typed on separate sheets. Every table should contain a descriptive title.

FIGURES should be drawn with Indian ink on good tracing paper. It is most important that the lines and letters are sufficiently bold to permit reduction to the *Journal* size. Captions should be typed on a separate sheet.

MATHEMATICAL SYMBOLS should be identified with pencil on the margins. Standard mathematical notations should be adhered to. Please distinguish between *kay* and *kappa*, *ell* and *one* and other similar symbols likely to cause confusion.

ABBREVIATIONS such as *e.g.*, *et al.*, and *i.e.*, can be used. If non-standard abbreviations or acronyms are used they should be explained where they appear first in the text.

GALLEY PROOFS will be sent to the authors for correction. They should be carefully scrutinised and returned within three days of receipt.

REPRINTS: Fifty reprints are supplied gratis. Additional reprints (up to 50) can be ordered while returning the corrected galley proof.

PAPERS received for publication are subjected to rigorous review process.

MANUSCRIPTS should be sent to the Editor, JOURNAL OF THE INDIAN INSTITUTE OF SCIENCE, C/O IISc Library, Bangalore 560 012, India.