ding to which neuroscientific explanations will finally be sufficient to fully explain human behaviour. His supervenience theory seems almost convincing to me. In fact, I think that any theory that is not along these lines – that mental events are dependent on their physical substrata but not reducible to them – is bound to fail. But this is perhaps the nature of any theory of complexity. (The editors missed the fact that his abstract is also the first part of the article, and it is printed twice.) There is much more material in this article than mentioned here, especially the interesting ideas on monism.

B. V. Sreekantan has been one of those few physicists who have been following developments in neural sciences and theories of mind and consciousness. He makes the interesting point that to understand the mind in terms of neural correlates and other observables, transcending some of the present ideas in physics and biology might be required. He gives examples from established physics to show that even within the rigorous physical theories, some of the concepts that originated in common experience have been elevated to the transcended concept that is beyond human experience and intuition. This again is an article that rightly argues that emergent properties can transcend the underlying material properties.

I skipped a serious reading of Manoj Samal's speculations on a unified theory of mind and matter, since the first reading gave the impression that it is full of speculations on speculations. Perhaps, I will discuss with him some of those points when I meet him next.

The panel discussion on metaphysical implication of modern science contained a provocative article by N. Kumar, with the thesis that the free-willed self-consciousness might not interact with the will-free neuronal brain. A fundamental problem with this assertion might be the unprovable statement that the self-consciousness is free-willed!

The second panel discussion deals with 'science and religion'. A more complete resource on this topic would be the proceedings of the 'Science and Spiritual Quest' conference held at NIAS in January 2003.

A volume that contains such a large variety of ideas and thoughts could have been compiled only from an international meeting organized in India by a reputed institute, since otherwise it would have been difficult to bring together many serious scholars familiar with the Indian knowledge and writings on consciousness studies. This alone highlights the uniqueness and value of this volume.

C. S. UNNIKRISHNAN

Gravitation Group,
Tata Institute of Fundamental Research,
Homi Bhabha Road,
Mumbai 400 005, India and
NAPP Group,
Indian Institute of Astrophysics,
Bangalore 560 034, India
e-mail: unni@tifr.res.in

General Lattice Theory. George Grätzer. Birkhauser Verlag, P. O. 133, CH-4010 Basel, Switzerland. 2003. 2nd edn. 663 pp. Price: Euro 73.

Mathematicians realized the significance of lattice theory only about seventy years ago. Since then, the theory has been developing rapidly. It was Garrett Birkhoff's (1911–96) pioneering work during 1930s which led to the general development of the subject. He established the importance of lattice theory in unifying seemingly unrelated developments in different mathematical disciplines. His three editions of the book *Lattice Theory* appeared in 1940, 1948 and 1967, respectively, have inspired many mathematicians to work in the field of lattice theory.

The first edition of the book under review appeared in 1978, and it surveyed most of the significant developments that took place in general lattice theory up to 1975. The only change in the present edition is the inclusion of eight new appendices along with an extensive, new bibliography.

The book is self-contained, starts from the basic concepts and proceeds quickly to reach the latest in the field. It is not an elementary, introductory book and a beginner would require much guidance to study the book. The book mainly intends to highlight major achievements in general lattice theory. The book does not cover all aspects of lattice theory. In fact, many of the areas of lattice theory like orthomodular lattices, continuous lattices, lattice-ordered algebraic structures, applications to logic, topology, analysis, etc. are not included in the book. Also, the theory of semimodular lattices is briefly touched upon to prove some representation theorems for general lattices. The book contains around 150 diagrams that are helpful in understanding the concepts (of course, figure III.3.2 on p. 199 is to be rotated clockwise by 90° to make it meaningful). About 900 exercises given in the book supplement the topics covered in each section and a list of more than 100 research problems posed are useful for researchers in the field.

The theory of distributive lattices and Boolean algebra is developed by an interaction of lattice theory, axiomatic set theory, logic, topology and ring theory. The book discusses basic characterization and representation theorems for distributive lattices, Boolean lattices and Stone lattices, including topological representation theorems for distributive and Boolean lattices.

Congruences and ideals are not directly related to each other in general lattices. However, these two are related naturally in a one-to-one manner only in generalized Boolean lattices due to a result of Hashimoto. Generalized Boolean lattices are Boolean rings in disguise, according to Stone. The congruence lattice of any lattice is known to be a distributive algebraic lattice. The converse of this statement is a long-standing conjecture of lattice theory. The author discusses some latest work in this direction in some special cases in one of the appendices.

Dilworth has successfully employed the notion of weak projectivity in characterizing principal congruence relations in arbitrary lattices. This enables the description of congruence relations generated by arbitrary subsets and of ideals that are kernels of some congruence relations. The notions of distributive, standard and neutral elements (and ideals respectively) defined by Ore, Gratzer and Birkhoff, respectively, play a significant role in general lattices. These can be defined by distributive identities and they carry properties of elements (and ideals respectively) of distributive lattices. The author, jointly with Schmidt, had developed the theory of standard ideals in lattices similar to the theory of normal subgroups in groups. Neutral elements and ideals play an important role in direct decomposition of lattices. The chapter on congruences and ideals discusses some aspects of these interesting facts.

The theory of modular and semimodular lattices also has contributed to the general development of lattice theory. Birkhoff, Ore, von Neumann and others continued the study of modular lattices initiated by Dedekind. Several definitions of semimodular lattices can be found in the literature and these generalize modular lattices. Important among them are due to Birkhoff, Maclane, Wilcox and Maeda. The author considers semimodularity and M-symmetry and proves their equivalence in lattices of finite length. Geometric lattices arise from geometry and their structure theorem due to Maeda, improved by Sasaki and Fujiwara, asserts that every geometric lattice is isomorphic to a direct product of directly indecomposable geometric lattices. Also, the connection between geometric lattices and geometry, and geometric lattices arising from graphs are studied. Ore proved that the lattice of partitions of a set is a simple geometric lattice. Whitman's classical result (improved by Jonsson) shows that any lattice can be embedded in a partition lattice (has a type-3 representation), the significance of which can be compared with the corresponding theorem for groups, representing a group as a subgroup of a permutation group. In particular, it yields Whitman's result that every lattice can be embedded in the lattice of all subgroups of some group. Jonsson proved that a lattice L has a representation of type-2 if and only if L is modular and also that any lattice having type-1 representation in Arguesian. Complemented modular lattices and modular geometric lattices are closely related. One-to-one correspondence between projective spaces and projective geometries is discussed. The classical coordination theorem of projective geometry due to von Neumann is stated and a sketch of the proof is given. The theorem is regarded as one of the deep lattice theoretical results. Another important embedding theorem due to Frink, embeds a complemented modular lattice in a modular geometric lattice. The book also discusses related results of Jonsson, Dilworth and Hall.

The chapter on varieties of lattices summarizes relevant parts of universal algebra to lattice theory. It especially discusses the problem of finding equational bases and also amalgamation properties for varieties. In the chapter on free products, the notion of free products and rela-

ted results are employed to describe free lattices and also to simplify the proof of a celebrated result of Dilworth that any lattice can be embedded in a uniquely complemented lattice. The chapter proves many powerful structure theorems concerning free products. For many of these theorems, the author's contribution is also significant.

The eight appendices appended to the first edition of the book, cover some of the important developments in general lattice theory that took place after the release of the first edition. They are written by a group of experts (including the author) in those areas. These contain either new, major advances in lattice theory (especially reviews of solved problems of the first edition), new branches of lattice theory that have grown on their own, new developments on a longstanding problem or new applications of lattice theory to theoretical computer science, etc. The appendices give statements of many recent results, without proofs, after briefly motivating them, and conclude with valuable remarks and, in some cases, with open problems related to those results. These will be useful references for researchers in those areas due to the availability of an extensive, new bibliography in the book.

Overall the book is unique, authoritative and informative in the subject and useful not only for teachers and researchers in the field, but also to those whose areas interact with lattice theory. The author's significant contributions to several chapters of the book are both astonishing and praiseworthy. A book of this kind demands vast research experience, collaboration and cooperation of a team of experts that the author was fortunately enjoying. The book gives a strong foundation in general lattice theory. It can motivate research workers in the subject and also raise curiosity among general mathematical community to know more about lattice theory, because lattices occur almost everywhere.

S. PARAMESHWARA BHATTA

Department of Mathematics,
Mangalore University,
Mangalagangothri 574 199, India
e-mail: s_p_bhatta@yahoo.co.in

This volume is a collection of 16 timely reviews by scientists of repute from India and abroad, spanning various aspects of plant biochemistry, molecular biology and biotechnology. It marks the beginning of what seems to be an annual series (at least) to be published by the Society for Plant Biochemistry and Biotechnology, Indian Agricultural Research Institute, New Delhi. Though the Society publishes a journal by the same name, this volume is not a compilation of reviews already published in that journal, nor is it based on the proceedings of any conference. The authors have been drawn from India, USA, Canada, the Netherlands, Mexico and France. Almost all the reviews are up-to-date with the latest references (up to 2001), some have even included 'notes added in proof'. To that extent, this inaugural volume scores well on its fundamentals and seems to set the right tone for future issues of the series. This is no small achievement for an Indian Society, despite the fact that there are dozens of world-class journals and review series in plant sciences ranging from monthly to yearly frequency, publishing excellent reviews from all over the world. However, almost all of them are from abroad and are either inaccessible or unaffordable to the vast majority of Indian researchers, and especially college and university libraries. By publishing this review series incorporating up-to-date information in an affordable form, the Society is doing a great service to the Indian community in this field.

The volume covers a whole range of topics of relevance to contemporary plant biochemistry, including the oxidative photosynthetic (C_2) cycle; DHAP reductases, cyanases, phosphoenol carboxylases, β-carbonic anhydrases, haemoglobins, cell plate and callose synthase, phosphate acquisition, lipid bodies in plastids, role of methanol and other single-carbon metabolites in plant signalling and growth, plant haemoglobins, etc. Some of these topics relating to plant metabolism and its regulation are of particular importance to the Indian readership, as they