mid-mediated iron transport virulence system of *Vibrio anguillarum* (Chapter 30), have been discussed. The chapter on urease makes very interesting reading wherein genetic organization and regulation of urease genes of members of enterobacteriaceae (*Proteus mirabilis*, *Klebsiella aerogenes* and *E. coli*), gram positive bacteria (*Staphylococcus saprophyticus* and a thermophilic *Bacillus* sp.) and *Helicobacter pylori* have been discussed.

Part 6 – 'Other aspects of bacterial pathogenesis' – is an assemblage of assorted aspects of bacterial pathogenicity which arose during Falkow's work detailed in the preceding chapters. None of these topics have been dealt with in previous compilations on the subject. It is apparent that these aspects of bacterial pathogenicity would constitute important areas of research in the future.

The enzyme systems responsible for sucrose transport, sucrose hydrolysis and synthesis of extracellular and intracellular polymers have been viewed as pivotal virulence factors for the cariogenic *mutans* streptococci. Newer tools which may help elucidate molecular mechanisms underlying synthesis, regulation and interrelations of these enzymes have been discussed (Chapter 31).

In general, it is very well-known that several factors, both host and pathogen, determine the minimum inoculum required to produce a disease in susceptible hosts. In this regard genetic determinants of acid resistance of *Shigella* spp. have been discussed (Chapter 32). However, the thought-provoking question in this chapter is: Are there any specific factors which dictate infective dose of a pathogen?

A great deal of progress has been made in recent years in the field of mucosal vaccines. Various aspects of the subject discussed include – cholera toxin subunit B as a model for the development of nonliving mucosal vaccines, its use as an adjuvant for other mucosal vaccines and live mucosal vaccines as carriers of heterologous antigens (Chapter 33).

The discussion on phylogenetic diversity of microbial pathogens (Chapter 34) brings into focus the bias of *in vitro* growth enrichment methods towards bacteria isolated from the environment. To what extent are these methods relevant to microbial flora of mammals? The inadequacy of these methods has been illustrated by the identification of unculturable pathogens directly from host tissue using PCR-amplified 16S rRNA sequences.

Since this volume is meant to be a tribute to Stanley Falkow, all the contributors are his former students, postdoctoral fellows or collaborators. So only those aspects of bacterial pathogenicity which have been pursued in his laboratory are reviewed. Nevertheless, it encompasses not only a good range of microbial pathogens and virulence determinants but also incorporates certain aspects, especially in Part 6, hitherto not dealt with in any of the previous works on this subject.

The book has the characteristic stamp of the American Society for Microbiology, i.e. highly authoritative and immensely readable.

All in all, this volume should form an important part of any collection, whether individual or library, dealing with bacteriology, medical microbiology, bacterial pathogenesis or infectious diseases.

J. S. VIRDI

Department of Microbiology,
University of Delhi South Campus,
Benito Juarez Road,
New Delhi 110 021, India.

Life in Moving Fluids. Steven Vogel. Princeton University Press, 41, William Street, Princeton NJ 08540, USA. 1994. 2nd edn. 467 pp. Price: $ 49.50, £ 35.

Scientists of yesteryears were known as natural philosophers: people who wondered about the workings of Nature. They appear to us as free souls, knowing no boundaries of specializations, and venturing into any body of knowledge to seek an explanation to some riddle that caught their imagination. The book *Life in Moving Fluids* by Steven Vogel is a beautiful one, one that revives the memories of the natural philosopher. It is an account of a biologist stepping out of his customary confines and thinking about the effects of flow on life in moving fluids.

Fluid mechanics has become a subject highly mathematized with a quest for exact results. The advent of high-speed computers has only enhanced this trend, and the frontier is occupied by computations of creeping flows, direct numerical simulations of turbulent flows, etc. All this is not a criticism of what goes on in fluid mechanics, but one does wonder: Is there any room for natural philosophers in fluid mechanics? Vogel's answer is an emphatic yes.

The book is structured as follows: Each chapter begins with an introduction of a set of fluid-mechanical concepts, followed by the role they play in a wide variety of biological phenomena. The discussion is clear and simple, and the speculations are intriguing. The author also describes many simple experiments done by himself. The gentle humour which he employs in his exposition is a bonus.

The book begins with the notion of a fluid and that all important property – kinematic viscosity. Here we learn how viscosity plays an important role in the lives of antarctic mammals and birds, and affects the morphology of some microcrustacean species. Then follow the very important concepts of kinematics: conservation of mass and streamlines. Based on these simple ideas one can calculate the number of capillaries in our body, even without needing the proverbial back of an envelope. The next topics are pressure and momentum. A clean derivation of Bernoulli's equation, and nice examples of flow measurements are presented. The ideas of pressure distribution and lift forces follow naturally, giving rise to beautiful examples of how these principles are 'used' by organisms to generate secondary flows, e.g. by termites to ventilate their mounds. All this leads up to a discussion of Newton's second law. It is nicely tied up with jet propulsion. It is really incredible that many living beings move by this principle, and belong to the 'jet set'!

The next few chapters drag 'drag' into focus. The new player is the Reynolds number. Here the origin of the drag force, the vagaries of the drag coefficients, separation of flow, streamlining of shapes, and scale modelling are explained in a very clear manner. Some of the author's own clean and simple experiments on scale modelling are presented. Application of the principles of drag to biological systems leads to an immediate complication since the shapes of living things are flexible and hence can interactively change with flow. Thus, there can be no discussion of 'dragginess' of a shape. All these ideas are discussed in the context of trees, microalgae, motile animals, etc., giving scope for some interesting questions involving evolution of shapes.

The next subject is velocity gradients, and boundary layers are introduced in a simple way laying emphasis on the geometries encountered in biological systems. Vogel captures the essence of boundary layer by saying that 'it is a place to hide from drag'. But, of course, hideouts have disadvantages too, since then there is a barrier to exchange of matter and energy. Consequently, there arise a whole lot of optimal existential problems. Thus, 'there is a price in drag to be paid versus paying in the harder currency of lift' due to their asymmetric shapes, cost of drag to be balanced against being away from the source of food, and penalty to be paid in terms of dispersal of spores for saving on drag, etc.

Then come the important concepts of vorticity, circulation and lift. Common mechanisms by which vorticity is generated are discussed followed by the topics of gliding, soaring, flying, and swimming.

The internal flows occupy the attention of the author in the next few chapters. As usual, the prototypical pipe flow is discussed. Here again the balance between power required to maintain the flow versus the decreased transport rates from wall in the absence of convection is brought to focus. Another problem faced by big organisms is the distribution of nutrient-carrying fluids to various corners of the body. This gives rise to Murray's law with its wide-ranging validity. This is fairly important given that the fraction of the metabolic rate spent on keeping the flow is considerable.

The next topic covers the low Reynolds number external flows. Here the flow is slow and the transfer rates are also low. Diffusion is the source of food, and one would have to work very hard to move in order to enhance the transport rates. Though motility is available, one is perhaps better off waiting, a fact humorously explained by the notion of 'a casual cow who, after eating, just waits for the local grass to regrow'. No discussion of creeping flows is complete without a discussion of terminal velocities. Vogel points out its relevance to survival, by citing the various structures developed by airborne particles – pollen grains, etc. – in order to maximize the dispersal distance, which has a direct bearing on fitness. The long rangedness of low Reynolds number flows is beautifully brought out by showing its relevance to information transfer by flow disturbances in the environment. The creepy games of preys and predators are subject to this feature of the creeping flows. The book ends with a discussion of unsteady flows and effects of interfaces.

Vogel intended this book to be treated, in part, as an argument that the unavoidable imperatives of mechanics of fluids underlie the biological design. He succeeds eminently in his presentation.

Here the interview of G. I. Taylor by G. K. Batchelor comes to my mind (*J. Fluid Mech.*, 1975, **70**, 625). In response to a query about the important areas in fluid mechanics, Taylor mentions the problem 'Why does a tree grow upward?'. What role did Taylor see in this problem for fluid mechanics, and, if he were alive, what would he have done regarding this or other such issues? Great minds are difficult to comprehend but it is easy enough to see that he was wondering about nature and was seeking the role of flow in nature. Taylor would certainly have given beautiful and simple resolutions of some of the issues raised in this book by Vogel.

I recommend Vogel's book to all interested in fluid mechanics. Even conventional courses on fluid mechanics can be enriched and made interesting by choosing elements from it.

K. S. GANDHI

Department of Chemical Engineering,
Indian Institute of Science,
Bangalore 560 012, India.

Annual Review of Neurosciences 1995. W. Maxwell Cowan. Annual Reviews Inc., 4139 El Camino Way, Palo Alto, P.B. No. 10139, California 94303-0139, USA. Price: USA $ 47, elsewhere $ 52. 607 pp.

This issue of the *Annual Review of Neurosciences* covers a wide range of interests. The first article by Phillipe Soriano is on the use of embryonic stem cells for making transgenic mice. This powerful technique has been used to develop targeted mouse mutants for specific neuronal receptors. The article deals primarily with the technical advances made in this field, which have been considerable. However, for those of us interested in learning more about the contribution of targeted mice mutants to the understanding of neurobiology, the article serves more as a catalogue. A perspective on fresh neuroscientific insights obtained as a consequence of this method would have been welcome. A number of articles review the recent advances made in the understanding of various human neurobiological diseases. Of these, the article by Suter and Snipes on peripheral neuropathies, has integrated nicely knowledge from basic molecular research on the components of the myelin sheath, with information from genetic and clinical studies. The article by Warren and Ashley Jr on the fragile X syndrome sheds important light on the role of triplet repeats in causing genetic mutations. On reading this review it appears likely that the triplet repeat expansion mechanism may serve as a cause of many, as yet poorly understood, neurological disorders. A suggested role for genomic imprinting during this process makes this mechanism all the more intriguing. The review article on neurobiology of infantile autism (Ciaranello and Ciaranello) highlights the lack of understanding regarding the cause(s) of this human disease. It appears to have a genetic basis and may in some cases be associated with other neurological disorders.

A number of articles in this review have tried to put together recent experiments in understanding the development of the vertebrate central nervous system (CNS). Hatten and Heinz discuss the general principles that have emerged from studies of the development of the cerebellar cortex. This particular brain tissue serves as a good model system since it is relatively less complex and its structure is well-understood. Analysis of its development has been further aided by the presence of mutants in which parts of the cerebellar cortex do not develop properly. Colamarino and Tessier-Lavigne have reviewed the vast array of information implicating molecules in the floor plate as cues for axon guidance in the developing CNS. Many of these molecules still remain to be identified while others such as Netrin-1 and aminin are being studied extensively. Another interesting molecule is agrin, which has been shown to play an important role in the formation of the neuromuscular synapse. Bowe and