Journal of Statistical Physics, Vol. 40, Nos. 3/4, 1985

Book Review: *Random Walks in Biology*

Random Walks in Biology. Howard C. Berg. Princeton University Press, Princeton, New Jersey. 142 pp.

The microscopic world seen by cell biologists abounds in objects which are buffeted about by thermal fluctuations. Macromolecules, cellular organelles and microorganisms are all subject to Brownian motion. The balance between diffusion and drift is at the heart of the particle separation methods of molecular biology, such as centrifugation, electrophoresis, or chromatography. Motile bacteria swim stochastically in a world at low Reynolds number. These phenomena are the subject of this short, elegant book by Howard Berg.

The book contains a series of lectures on the physics of diffusion and other random-walk phenomena. The lectures are addressed to biologists, stressing physical insight, and avoiding detailed mathematics. When explicit solutions to diffusion equations are needed, the author simply states them and then analyzes their implications. For example, several different diffusion situations and an electrical analog are used to show the reader why diffusive flux into an absorber is proportional to perimeter and not area. The same reasoning is then used to explain such phenomena as the diffusion of gases through leaf stomata and the function of receptor sites at cell surfaces.

In discussing diffusion at equilibrium, Berg introduces the Boltzmann distribution. He then derives the Einstein–Smoluchowski relation and applies it to the analysis of sedimentation and isoelectric focusing. In all these discussions, the random walk of particles in a viscous medium is examined directly with no recourse to thermodynamic formulas.

A high point of the book is the chapter on the movement of self-propelled objects. This is an application of random-walk ideas to the physics of bacterial locomotion. Chemotactic bacteria move by flagellar propulsion under low-Reynolds-number conditions. They can swim fitfully up gradients of attractive substances because the molecular motors which rotate their flagella undergo stochastic transitions that are modulated by reception of attractant molecules. The chapter teaches stochastic reasoning while introducing and describing a fascinating area of biophysics research.

0022-4715/85/0800-0609$04.50/0

The book would make an excellent supplementary text to a biophysics course or provide a physically minded biochemist with a good conceptual background for understanding the physics of most of the particle separation methods he is likely to encounter. Statistical physicists will find the variety of random walks in biology to be a source of interesting stochastic problems worthy of their attention.

Harold Lecar
Laboratory of Biophysics
National Institute of Neurological and Communicative Disorders and Stroke
National Institutes of Health
Bethesda, Maryland 20205