BOOK REVIEWS

Invertebrate Immunology

Phylogenetic Perspectives in Immunity. The Insect Host Defense. JULES A. HOFFMANN, CHARLES A. JANEWAY, JR., and SHUNJI NATORI, Eds. Landes, Georgetown, TX, 1994 (distributor, CRC Press, Boca Raton, FL). xviii, 197 pp., illus. $89.95 or £74. Molecular Biology Intelligence Unit.

Like other scientists, immunologists seek basic understandings of complex biological processes; when it comes to complexity, adaptive immunity has few equivalents. An "evolutionary" study provides one means of gathering a simpler or (more realistically) different view of a fundamental form, relationship, or mechanism. However, there are some problems with this approach, not the least of which is that the clues being sought may have long since been erased. Furthermore, the mammalian system, clearly the dominant focus of present biological interest, is so specialized as to be inappropriate for comparison with organisms (such as insects) that pass through major life points in periods that are insignificant relative to the decades that mark the lives of mammals. Ironically, it was studies of invertebrate innate immunity by Elie Mechnikoff in the 1880s that provided the foundation of modern cellular immunology. After more than a hundred years of controversy over the issue of invertebrate immunity, it seems that at least one major group of invertebrate models, the insects, have come into their own. *Phylogenetic Perspectives in Immunity: The Insect Host Defense* summarizes the foundations of our current concepts of the character of immunity in this highly diversified group.

The strength of this work is that its various chapters are focused on critical interpretations of data that largely reflect relevant immune challenges to the species at issue. In case the reader is looking for T and B cells, somatic gene arrangement, and positive selection for increasing affinity of antigen receptors, contributors Boman and Davidson, as well as co-editors Janeway and Hoffmann, clarify the lack of evidence for and improbability of their existence outside of the vertebrates. Along with the excellent introduction to the volume, Boman's opening chapter contains a critical interpretation of his own and others' work, giving the reader a framework for interpreting entomological immunology.

Although little previously unpublished information is put forward in the book, past discoveries, misdirected lines of investigation, and incorrect inferences as well as possible future areas of endeavor are depicted clearly. Several chapters contain summaries of properties of antibacterial or antifungal peptides and other substances and take on an encyclopedic character, but these mercifully avoid farfetched claims of amino acid identities and speculative leaps that postulate homology with the primary mediators of vertebrate adaptive immunity. Even in the encyclopedic approach there is considerable merit—perhaps these molecules afford some new concepts for design of antibiotics, a matter worthy of concern as the dwindling resources of the pharmacologist and chemist are being outpaced by deadly genetic accommodations of infectious agents. The book consistently focuses on immunity in the insect; but you can take what you want from the descriptions of some of the well-established linkages between invertebrate and mammalian immunity—the complement system, mannose-binding proteins, cytokines, and so on. The issues of general similarities between insect immune responses and acute-phase reactants in mammals are not overlooked.

The organization is logical, and as a result of careful ordering of the chapters as well as through that rarest of multi-contributor phenomena, accurate cross-referencing, the book can be read from cover to cover with relative ease. Given these stylistic endorsements, what messages come through? First, the evidence for antibacterial and other responses to infectious agents is compelling. A wide variety of molecules exhibit the effects, and homologs of some can be found in the vertebrates. Certain antibacterial responses are inducible, and Hoffmann *et al.* and Hultmark show that the genes flanking some mediators of antibacterial activity contain transcriptional regulatory sequences that have been implicated in the control of immune processes in mammals. Thus, in the broadest evolutionary context, a thread can be drawn through not only constitutively expressed genes but also the inducible systems.

Perhaps this is not all coincidental. Davidson develops the single most significant evolutionary theme in this text—how major regulatory systems emerge and change. This is not a dissertation on a molecular clock ticking away residue by residue on the face of a structural domain, but rather a consideration of macro events that abruptly alter or integrate developmental and other genetic control processes. Viewed in this light, it is evident that the mediators of insect immunity are unrelated by any stretch of molecular systematics to antibody, but the transcriptional regulation of an immunoglobulin locus and a *Drosophila* inducible response may have much in common. One need not look further than the work emerging recently from the laboratories of Fred Alt and others, in which ancient DNA repair processes lie at the heart of one of the key mechanisms that somatically diversify antibodies and T cell antigen receptors, to comprehend the scope of integration of preexisting systems.

If it is answers that you want as to how the sophisticated mechanisms of segmented gene rearrangement and somatic hypermutation found in all jawed vertebrates evolved, there are several protochordate subphyla and an entire vertebrate class (the Agnatha, or jawless vertebrates) that probably hold more immediately relevant information than can be garnered through studies of insects; however, this book comes as close as any that I have seen to objectively addressing the topic of immunity in a nonvertebrate metazoan and documenting that you do not necessarily need B cell activation and an Fc receptor on a macrophage to kill a bacterium. Given the extraordinary diversity of life form within the insects, it would come as no surprise that there is much more to be learned from these species about the most basic aspects of host response to disease.

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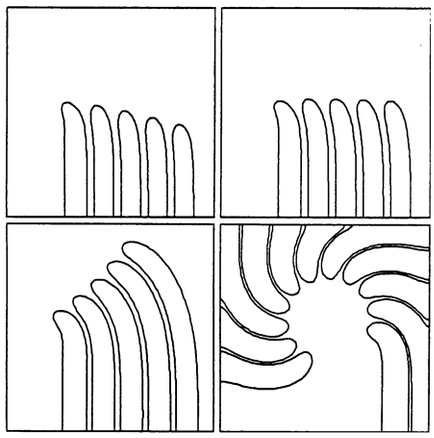
Diffusion Phenomena

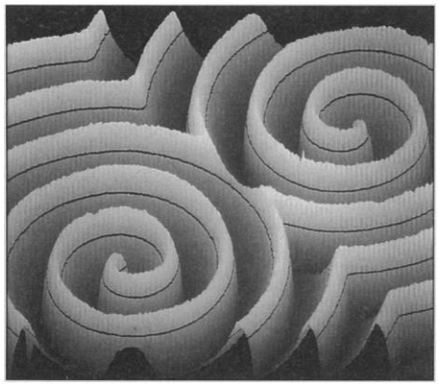
Chemical Waves and Patterns. RAYMOND KAPRAL and KENNETH SHOWALTER, Eds. Kluwer, Norwell, MA, 1995. x, 641 pp., illus. $272 or £179 or Dfl. 425. Understanding Chemical Reactivity, vol. 10.

It might seem that the effect of diffusion in a spatially distributed, unstirred molecular system would be to make homogeneous the spatial concentration distribution of chemical species. However, the opposite can be true. It occurs in complex reacting systems with appropriate feedback loops in their



"Evolution of a broken excitation wave in a reaction-diffusion model of an excitable medium. Contours of constant activator concentration are shown at subsequent time moments for four differed excitabilities of the medium." [From A. S. Mikhailov and V. S. Zykov's paper in *Chemical Waves and Patterns*; V. A. Davidov *et al.* in *Nonlinear Waves in Active Media*, A. Crighton and Yu. Engelbrecht, Eds. (Springer-Verlag, 1989)]

mechanism. Many of these reactions also show temporal oscillation in intermediate concentrations when stirred. Diffusion in such cases can and does lead to the development of spatial concentration gradients supported by free energy dissipation in a far-from-equilibrium state. This fact is of considerable importance in understanding spatial organization in both chemical and biological systems. Thus, in 1906 Robert Luther suggested that coupling of an autocatalytic reaction with diffusion in an excitable medium can lead to traveling waves (now known as trigger waves) of reaction and associated sharp concentration gradients, and that these waves are dynamically very similar to nerve impulses as well as to other biological information-transfer mechanisms. Though the result was challenged at the time by Walther Nernst, Luther deduced, probably by dimensional analysis, that the velocity of the traveling wave is proportional to the square root of the product of the rate of the autocatalytic reaction and the diffusion coefficient, a result that has proven to be true. When challenged by Nernst on the derivation of this relationship, Luther simply replied, "*aus mir*." It was not proven rigorously until much later, although the connection to nerve impulse transmission was seen by Fisher and Kolmogorov in the 1930s.



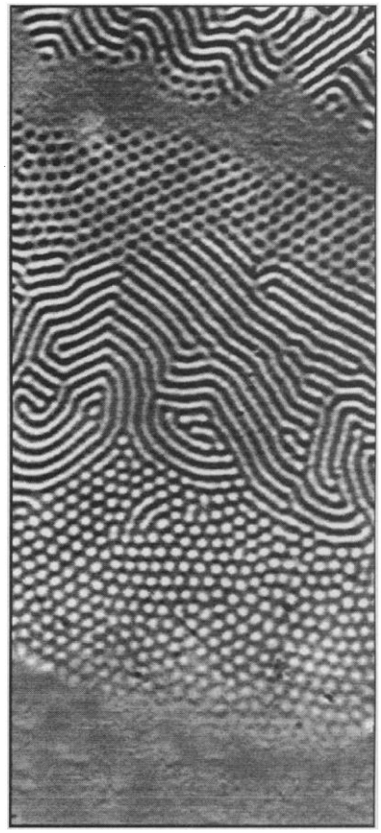
"Symmetric pair of spiral waves in a 1 mm layer of an excitable [Belousov-Zhabotinsky] reaction. The grey levels of transmitted light intensity (490 nm) measured for a 410 × 410 pixel frame are connected by linear interpolation (surface image) and displayed in three-dimensional perspective at a tilt angle of 45°. A narrow iso-intensity interval is enhanced in black." [From S. C. Müller and T. Plesser's paper in *Chemical Waves and Patterns*]

Even more remarkably, Alan Turing, the British polymath of enigma-machine fame, demonstrated in 1952 that the coupling of diffusion with reaction can actually destabilize a spatially homogeneous steady state if the chemical mechanism involves both activator and inhibitor species and appropriate feedback loops. The development of stationary concentration patterns then can result from a symmetry-breaking transition occurring as some parameter of the system, such as temperature or a concentration, is varied. This breaking of spatial symmetry results from differences in the diffusion coefficients of the activator and inhibitor. Turing suggested this phenomenon, called a Turing pattern, as a chemical basis of morphogenesis and of pattern formation in general in biological systems.

These profound insights languished until recently for two reasons: there was not a suitable body of theory of nonlinear partial differential equations within which to understand them, and, especially in the case of the Turing patterns, there were no experimentally accessible, chemically well-understood examples. That now has all changed. Experimentally, the Belousov-Zhabotinsky reaction provided, starting in the 1970s, a robust example of trigger waves in a mechanistically well-understood chemical system. Furthermore, in 1990 unstirred flow reactors not subject to convection were cleverly constructed and Turing patterns were discovered under circumstances where their development and properties could be carefully investigated. These advances led to an explosion of experimental and theoretical work and to new insights, all of which this book covers in breadth and depth. Each of the 18 variously authored chapters is well documented to provide a key to the supporting literature.

Trigger-wave dynamics is covered in great detail, including their initiation, the stability of their wave fronts, and their propagation in inhomogeneous media. Disruption of trigger waves either mechanically or in a inhomogeneous medium leads to very complex behaviors. Spiral waves may form in a thin, essentially two-dimensional, layer of reaction medium. Scroll waves of great complexity develop in three dimensions. These structures are expected to be of considerable interest, especially in the area of wave propagation in a muscle such as a beating heart.

The chlorite-iodide-malonic acid (CIMA) system is the only one in which Turing patterns have been seen experimentally. The construction of the reactors is explained, and the phenomena observed so far are systematically reviewed. The chemical mechanism of the CIMA reaction is used to simulate and interpret experimental results. The existence of so many experimental data has prompted significant theoretical investigation into the general properties of reaction-diffusion partial differential equations. In particular the mechanism of pattern formation in terms of the combination of normal spatial modes of perturbations around the spatially homogeneous steady state is reviewed. The connection is made between theory and experiment for various



Turing patterns: Stationary concentration patterns resulting from the sole interplay of a local nonlinear chemical reaction (CIMA reaction) and the fickian diffusion of the species in the reacting solution. The sequence of different planforms is obtained in an open spatial reactor with a smooth ramp of control parameter, by E. Dulos, J. Boissonade, and P. De Kepper, contributors to *Chemical Waves and Patterns*; courtesy of P. De Kepper.

Vignettes: Concern for Animals

Where the women's movement and the struggle of black women and men have been identity movements, made by those people declared Other by those with power, animal liberation was to be carried out by human beings on behalf of others. Arguably the silence of the oppressed was a significant part of their attraction; the liberators could speak on their behalf unfettered by any voices which said "that is not how I feel, that is not how I am, how dare you presume to speak for me."

—*Hilary Rose*

A question I have often wondered about is whether most students who feel uneasy about dissecting anesthetized animals actually do so out of sympathy with the animals. Would they do whatever is necessary to help an injured animal, or are they just uneasy about handling live animals? I wonder about this especially when I am told that women students are more reluctant to do lab dissections than the men are. Are we really dealing with differences in empathy with other living creatures or with differences in permitted squeamishness?

—*Ruth Hubbard*

—From *Reinventing Biology: Respect for Life and the Creation of Knowledge* (Lynda Birke and Ruth Hubbard, Eds.; Indiana University Press)

bifurcation (qualitative change in behavior) phenomena observed or expected as a control parameter is varied.

A beginning is made at drawing a connection between fluctuations at the microscopic level and macroscopic behavior. Fluctuations may become important near bifurcation points or in chaotic systems, and it seems likely that chemical patterns may be a good area for investigating their effect. These treatments are mainly on the mesoscopic level.

This book provides a current and vital review of an important and active area of research.

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Books Received

Automation in the Laboratory. W. Jeffrey Hurst, Ed. VCH, New York, 1995. xii, 248 pp., illus. $95.

The Axemaker's Gift. A Double-Edged History of Human Culture. James Burke and Robert Ornstein. Grosset/Putnam, New York, 1995. xviii, 349 pp., illus. $27.95 or $C37.95.

Bacteria. In Biology, Biotechnology and Medicine. Paul Singleton. 3rd ed. Wiley, New York, 1995. x, 319 pp., illus. Paper, $29.95.

Children Solving Problems. Stephanie Thornton. Harvard University Press, Cambridge, MA, 1995. x, 143 pp., illus. $24.95; paper, $10.95. Developing Child.

Climate Change and Agriculture. Analysis of Potential International Impacts. Cynthia Rosenzweig *et al.*, Eds. American Society of Agronomy, Madison, WI, 1995. xviii, 382 pp., illus. Paper, $34. ASA Special Publication no. 59. From a symposium, Minneapolis, Nov. 1992.

Collecting Plant Genetic Diversity. Technical Guidelines. Luigi Guarino, V. Ramanatha Rao, and Robert Reid, Eds. CAB International, Oxford, UK, 1995 (U.S. distributor, University of Arizona Press). xx, 748 pp., illus. $120.

College Physics. Raymond A. Serway and Jerry S. Faughn. 4th ed. Saunders, Philadelphia, 1995. xxvi, 1042 pp., illus., + supplementary material. $73.50.

Color and Light in Nature. David K. Lynch and William Livingston. Cambridge University Press, New York, 1995. xiv, 254 pp., illus. $44.95; paper, $29. 95.

Computer Simulation of Polymers. E. A. Colbourn, Ed. Longman Scientific and Technical, Harlow, Essex, UK, and Wiley, New York, 1994. viii, 343 pp., illus. $185. Polymer Science and Technology.

Confronting Poverty. Prescriptions for Change. Sheldon H. Danziger, Gary D. Sandefur, and Daniel H. Weinberg, Eds. Oxford University Press, New York, 1994. xii, 529 pp., illus. $49.95; paper, $19.95. Based on a conference, Madison, WI, May 1992.

Conserving Wildlife. International Education and Communication Approaches. Susan K. Jacobson, Ed. Columbia University Press, New York, 1995. xxxiv, 302 pp., illus. $45 or £31.50; paper, $22 or £16.75. Methods and Cases in Conservation Science.

Constructing Knowledge in the History of Science. Arnold Thackray, Ed. History of Science Society, Philadelphia, 1995 (distributor, University of Chicago Press). viii, 253 pp., illus. $39; paper, $25; to HSS members, $27.50; paper, $17.50. *Osiris*, 2nd series, vol. 10 (1995).

Cooperative Phenomena in Jahn-Teller Crystals. Michael D. Kaplan and Benjamin G. Vekhter. Plenum, New York, 1995. xvi, 425 pp., illus. $95. Modern Inorganic Chemistry.

Coping with Trouble. How Science Reacts to Political Disturbances of Research Conditions. Uwe Schimank and Andreas Stucke, Eds. Campus, Frankfurt, and St. Martin's, New York, 1994. 401 pp. $59.95.

Coulson and Richardson's Chemical Engineering. Vol. 3, Chemical and Biochemical Reactors and Process Control. J. F. Richardson and D. G. Peacock, Eds. 3rd ed. Pergamon (Elsevier Science), Tarrytown, NY, 1994. xx, 776 pp., illus. $135 or £83; paper, $46 or £28.50.

Critical Issues in Systems Theory and Practice. Keith Ellis *et al.*, Eds. Plenum, New York, 1995. xviii, 712 pp., illus. $79.50. From a conference, Hull, UK, July 1994.

Evolution as Growth of One Earth-Organism. Thomas A. Morrill. Published by the author, Rt. 16, Box 9047, Tallahassee, FL, 1995. vi, 121 pp. Paper, $10 or £10.

Experiment and the Making of Meaning. Human Agency in Scientific Observation and Experiment. David Gooding. Kluwer, Norwell, MA, 1995. xviii, 310 pp., illus. Paper, $29.50 or £19.50 or Dfl. 55. Science and Philosophy, vol. 5. Reprint, 1990 ed.

Social Psychiatry across Cultures. Studies from North America, Asia, Europe, and Africa. Rumi Kato Price, Brent Mack Shea, and Harsha N. Mookherjee, Eds. Plenum, New York, 1995. xviii, 226 pp. $42.50. Topics in Social Psychiatry.

The Solar-Terrestrial Environment. An Introduction to Geospace—the Science of the Terrestrial Upper Atmosphere, Ionosphere and Magnetosphere. J. K. Hargreaves. Cambridge University Press, New York, 1995. xiv, 420 pp., illus. $100; paper, $37.95. Cambridge Atmospheric and Space Science, 5. Reprint, 1992 ed.

Somatic Embryogenesis in Woody Plants. Vol. 1, History, Molecular and Biochemical Aspects, and Applications. S. Mohan Jain, Pramod K. Gupta, and Ronald J. Newton, Eds. Kluwer, Norwell, MA, 1995. xiv, 460 pp., illus. $205 or £134.50 or Dfl. 320. Forestry Sciences, vol. 45.

Space. A Vital Stimulus to Our National Well-Being, and World Space Programs and Fiscal Reality. Gayle L. May *et al.*, Eds. American Astronautical Society, San Diego, 1994 (distributed by Univelt, San Diego). xvi, 318 pp., illus. $70; paper, $50. Science and Technology Series, vol. 83. From symposia, Alexandria and Arlington, VA, April 1992 and March 1993.

The Space Environment. Implications for Spacecraft Design. Alan C. Tribble. Princeton University Press, Princeton, NJ, 1995. xiv, 204 pp., illus. $49.50 or £32.50.

Stability of Superconductors. Lawrence Dresner. Plenum, New York, 1995. xx, 225 pp., illus. $49.50. Selected Topics in Superconductivity.

Stairway to the Mind. The Controversial New Science of Consciousness. Alwyn Scott. Copernicus (Springer-Verlag), New York, 1995. xx, 229 pp., illus. $25 or $C35.

The Stone Skeleton. Structural Engineering of Masonry Architecture. Jacques Heyman. Cambridge University Press, New York, 1995. x, 160 pp., illus. $59.95.

Straight Sex. Rethinking the Politics of Pleasure. Lynne Segal. University of California Press, Berkeley, 1994. xvi, 376 pp. $35; paper, $15. Reprint, 1994 ed.

Structure Correlation. Hans-Beat Bürgi and Jack D. Dunitz, Eds. VCH, New York, 1994. liv, 888 pp., illus. $235.

Sulfate-Reducing Bacteria. Larry L. Barton, Ed. Plenum, New York, 1995. xvi, 336 pp., illus. $85. Biotechnology Handbooks, vol. 8.

Surface Infrared and Raman Spectroscopy. Methods and Applications. W. Suëtaka, with the assistance of John T. Yates, Jr. Plenum, New York, 1995. xiv, 270 pp., illus. $59.50. Methods of Surface Characterization, vol. 3.

Tinkering Toward Utopia. A Century of Public School Reform. David Tyack and Larry Cuban. Harvard University Press, Cambridge, MA, 1995. viii, 184 pp., illus. $22.50.

Two Dimensional Spline Interpolation Algorithms. Helmuth Späth. Peters, Wellesley, MA, 1995. viii, 304 pp., illus. $59.95.

"You Do Teach Atoms, Don't You?" A Case Study in Breaking Science Curriculum Gridlock. Lyman Lyons and Susan Bolyard Millar. LEAD Center, Madison, WI, 1995. xii, 79 pp., illus. Paper, $10.

Publishers' Addresses

Below is information about how to direct orders for books reviewed in this issue. A fuller list of addresses of publishers represented in *Science* appears in the issue of 26 May 1995, page 1220.

Kluwer Academic Publishers, P.O. Box 358, Accord Sta., Hingham, MA 02018-0358. Phone: 617-871-6600. Fax: 617-871-6528.

R. G. Landes Co., P.O. Box 4858, Austin, TX 78765. Phone: 512-863-7762. Fax: 512-863-0081. E-mail: rglandes@aus.computize.com.