and competition that have arisen in response to the challenge of unraveling the human genetic database. It grew out of a series of articles published at regular intervals starting in 1990 in the French periodical *médicine/sciences*. The reworking in book form, which, in the English translation at least, retains some of the flavor of the original articles, has been aimed broadly at "a relatively wide community of biologists, medical doctors and others interested in the topic."

Jordan writes persuasively; indeed, his talents in this area can be gauged from the support he was able to raise for his sabbatical plan to travel around the world and visit a selection of human genome research centers. In the first part of the book, an outline of the agenda of the human genome program is followed by a description of how genetic and physical maps can be produced. There is a certain lack of consistency in this account, and occasionally the chasm between the lay reader and the cognoscenti (of which Jordan is one) is exposed. For example, the nature and significance of yeast artificial chromosomes (YACs) are described in considerable detail, but then the term "cosmid" (a type of small-scale bacterial equivalent) is used with hardly any explanation. Nevertheless, the attempt at enlightenment is worthwhile and well illustrated.

Jordan goes on to highlight the apparent conflict between the objectives of reverse genetics (that is, positional cloning, dedicated to the isolation of individual genes from defined chromosomal regions) and the goals of the genome program (which demand mapping and sequencing on a much broader front). Although it is true that several laboratories may enter into apparently wasteful competition in order to isolate a key gene, the stimulus provided by such a prize can be instrumental in generating innovation and new technology. The importance of the funds provided by various charities, which have had an enormous impact in determining the direction of research, is not emphasized sufficiently. In addition to providing a specific focus, such organizations can play a significant role in reducing unnecessary overlap, as illustrated by the Muscular Dystrophy Association of America's orchestration of the research of several teams striving toward the isolation of the myotonic dystrophy locus. Strangely, considering that the isolation of a candidate gene for this extremely prevalent disorder represents one of the major successes of positional cloning, it is mentioned only once, and even then only in passing. Jordan complains that the targeted gene approach is "a situation reminiscent of cartographers responsible for preparing an overall map of a country who would survey solely those sites liable to contain oil deposits." The point is well taken—but, to continue the analogy, surely if one is exploiting new territory it makes more sense to bore oil wells than to sift sand.

Subsequent sections of the book provide a useful discussion of genome sequencing technology and its pitfalls and a pragmatic evaluation of the likely amount of time needed to complete the task. In discussing "high-tech" approaches, Jordan hits on the key fact that both mapping and DNA sequencing in isolation are tedious occupations and, once under way, provide little opportunity for those involved to develop scientific, as distinct from technical, skills. Motivation is an essential ingredient that may be in short supply in some genome endeavors. Overall, credit is given where deserved and the independent yet complementary roles played by microsatellites, YAC gridded libraries, complementary DNA (cDNA) isolation, and dedicated sequencing are given balanced treatment.

"HUGO in high seas." *Left to right*: Bertrand Jordan; Charles Cantor, active on behalf of HUGO in the United States; Elizabeth Evans, of HUGO's European office in London. [From *Travelling Around the Human Genome*; picture taken during the 2nd European HUGO meeting in Sardinia, April 1992]

Rather surprisingly, the sections that I thought would be least satisfying turned out to be full of insight, providing an amusing and reasonably convincing analysis of the impact of culture and social structure on the strategies adopted by the various national projects. Perhaps not enough credit is given to the contributions of the Human Gene Mapping Workshops, which have provided continuity in the field since 1973 and, together with the Baltimore-based Genome Data Base, have been responsible for the publication of edited cytogenetic location tables and genetic and physical maps—an essential service for the mapping community. More recently, these have been supplemented by single-chromosome workshops organized in conjunction with the Human Genome Organization (HUGO), which have provided both a stimulus and a focus for more widely based genome interests. Given the sometimes competing aims of national programs and the conflicting objectives of funding agencies, the hope must be that HUGO's status as a truly international coordinating body will be generally recognized.

The book's style is of the condescending "science can be interesting if presented properly" genre. There are subheadings on every page, ranging from such important insights as "Craig Ventner's interests extend beyond cDNA" to such illuminating comments as "Data processing is taken seriously." It has also proved difficult to hide the fact that the book is based on a collection of articles, and often the same points are made several times. In spite of this redundancy—indeed, even because of the fact that it is frequently superficial and idiosyncratic—it is quite fun to read.

Maybe the "take-home" message from Jordan's "travels" should be that good organization, relatively small teams, and motivation are just as important to the success of a large project as mega-funding—a point well illustrated by the publication in December 1993 of the Centre d'Étude du Polymorphisme Humain (CEPH)–Généthon first-generation physical map of the entire human genome.

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## The Structure of Memory

**Memory, Amnesia, and the Hippocampal System.** NEAL J. COHEN and HOWARD EICHENBAUM. MIT Press, Cambridge, MA, 1993. xiv, 330 pp., illus. $45 or £40.50.

The hippocampal formation has intrigued neuropsychologists and other neuroscientists since the report in 1957 of patient H.M., who underwent bilateral removal of this structure, together with surrounding brain tissue in the temporal lobes. This somewhat desperate surgery was performed to prevent life-threatening epileptic sei-

## Vignettes: Pitfalls of Evolutionism

I've seen plenty of psychologists with an interest in evolutionary biology. But I usually see people getting it wrong. Evolutionary biology has a very special status. It's like writing a novel in that everybody thinks that because they can read, they can write.

—*Elisabeth Lloyd*, in *Taking the Naturalistic Turn, or, How Real Philosophy of Science Is Done* (Werner Callebaut, Ed.; University of Chicago Press)

I question whether sociobiology should be taught at the high school level, or even the undergraduate level. . . . The whole message of sociobiology is oriented toward the success of the individual. It's Machiavellian, and unless a student has a moral framework already in place, we could be producing social monsters by teaching this. It really fits in very nicely with the yuppie "me first" ethos. . . . I think it's important to have a certain level of maturity, with values already settled, before this kind of stuff is taught.

—*Sarah Hrdy*, in Thomas A. Bass, *Reinventing the Future: Conversations with the World's Leading Scientists* (Addison-Wesley)

History is littered with the reputations of scholars who have struggled to discover normative advice in evolutionary behavior.

—*William H. Rodgers Jr.*, in *The Neurotransmitter Revolution: Serotonin, Social Behavior, and the Law* (Roger D. Masters and Michael T. McGuire, Eds.; Southern Illinois University Press)

zures, and it was, in that regard, quite successful, resulting in a dramatic decrease in both the frequency and the intensity of H.M.'s seizures. He is still alive today. However, as reported by W. B. Scoville (the neurosurgeon) and Brenda Milner (the neuropsychologist who has followed H.M. since 1957), another consequence of the surgery was an almost total anterograde memory loss, such that to this day H.M. does not recall events in his life since the time of the surgery. For example, he does not recognize Brenda Milner, despite having talked with her on numerous occasions over the past 37 years. This report triggered thousands of experiments aimed at deciphering the role of the hippocampus and temporal lobes in memory processes. Indeed, as the late James Olds once put it, the hippocampus became the "Rosetta stone of the brain" for neuropsychologists. In this book Cohen and Eichenbaum try to account for some of the key findings on the role of the hippocampal formation in memory processes. They develop a theory of hippocampal function that states, briefly, that the hippocampal formation is that system in the brain that is responsible for mediating declarative memory, while other regions of the brain (primarily the cerebral neocortex) are responsible for procedural memory. The concept of multiple memory systems in the brain is rather popular among neuropsychologists, and Cohen and Eichenbaum's ideas are, for the most part, reflective of current thinking in this field.

As proposed by the authors, declarative memory is characterized by representational flexibility as well as what they term promiscuity. Thus, memory processes carried out by declarative memory have access to the full range of interconnections among memory nodes in a representational system, so that items within that system can be manipulated, recalled, reorganized, and used in novel contexts. Declarative memory also provides a "binding" or "chunking" function such that stimuli in the to-be-remembered environment can be processed simultaneously. Because many cognitive psychologists might assume that a "declarative" memory system must be available to conscious recall (the authors themselves do not propose this), this system might better have been called "flexible." An example of its use would be recalling and describing an evening at the theater, complete with plot description, recollection of details of the scenery, comparison with other plays seen recently, and an account of the dinner one ate afterward.

The other major memory system proposed by the authors, procedural memory, is viewed as relatively inflexible, requiring repeated training trials in which synaptic connections in the stimulus-processing circuits are gradually modified. It is a dedicated system, its memory representations being largely unavailable to other processor systems. Skill training and classical conditioning, in the authors' view, are mediated by this memory system, which might also have been called "dedicated." An example of this system in action is classical conditioning of the nictitating membrane response.

The authors apply these basic theoretical ideas to seven experimental paradigms: delayed nonmatch to sample, spatial learning, conditional discrimination, sensory discrimination, skill learning, repetition priming, and recall and recognition. There is a voluminous literature reporting on studies involving these paradigms and employing rats, nonhuman primates, and human neurological patients. No one book could review even a majority of these studies, and the authors wisely are selective in what they cover. They propose that performance on various tasks cannot be predicted simply by knowing the paradigm; rather, "Performance of amnesics relative to control subjects depends on the extent to which variants of each task encourage or actually require the use of hippocampal-dependent declarative memory for successful performance" (p. 134).

The authors compare and contrast their ideas with several other theoretical positions regarding the hippocampal formation. The closest theory appears to be that of Squire and colleagues, who also ascribe to the hippocampal formation a declarative memory function while proposing that other, nonhippocampal, neural circuits mediate procedural or nondeclarative memory functions. Judging from the discussion given, the distinctions between these two points of view are subtle indeed.

Not surprisingly, the authors' analysis of existing work is consistent with their basic theoretical position. In fact, as one reads this book, the question of just what would disprove their theory comes to mind. The authors do address this question, but more specific and detailed predictions would have strengthened their argument. To put their theory to the test, Cohen and Eichenbaum suggest a two-stage approach: First, devise a series of experiments that vary systematically in their dependence on declarative memory (that is, the degree to which they require memory for relationship of items, the ability to manipulate stored representation, and the ability to use memory in new contexts). Second, use probe tests to determine whether performance does in fact reflect use of the declarative system. Although these are logical suggestions, discussions of experimental results in other sections of the book often leave the reader wondering whether one could conceive of results that could not be explained by this theory. For example, in their discussion of the finding that amnesics show normal

learning of the Tower of Hanoi spatial puzzle (despite the fact that these patients cannot consciously recall having encountered the task before), the authors ascribe to the procedural memory system the capacity for "cognitive problem solving and sequential planning procedures"—processes that the reader might reasonably think would require the representational flexibility that the authors reserve for the declarative memory system, which is presumably defective in these amnesics.

Neurophysiologists may be disappointed to find that Cohen and Eichenbaum do not provide a quantitative or computational model of hippocampal function. Moreover, devotees of the brain electrical pattern known as hippocampal theta may feel that this area has been shortchanged. Also, an author index would have been helpful. Overall, however, this is a serious and interesting attempt to organize a substantial portion of the literature on the functional role of the hippocampal formation. Neuropsychologists and others interested in the brain and human cognition will want to make sure they put their declarative memory to work on the arguments put forward in this book.

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## Promising Polymers

**Liquid Crystalline Polymers.** A. M. DONALD and A. H. WINDLE. Cambridge University Press, New York, 1992. xiv, 310 pp., illus. $100 or £55. Cambridge Solid State Science Series.

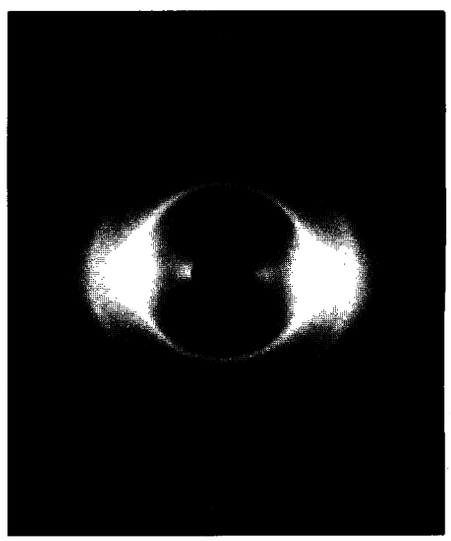
In the early 1970s physics Nobel laureate Pierre-Gilles de Gennes theorized on the diffusion of linear-chain macromolecules in condensed phases through "reptation." This motion was envisioned as the snakelike crawling of highly entangled flexible chains through imaginary tubes formed by surrounding macromolecules. Toward the middle of the same decade, Jerry Jackson and his colleagues at the Kingsport, Tennessee, laboratories of Eastman Kodak reported on the self-organization of linear-chain macromolecules into orientationally ordered liquid crystals. The polymer molecules that were found to form such nematic liquids had backbones stiffened by aromatic units and thus differed from those described as "flexible snakes." These polymers have rod- or board-shaped molecular segments that pack in parallel arrangement within domains that easily acquire dimensions in the range of microns. The discovery of liquid crystallinity in pure and synthetic polymers marked the beginning of a new chapter in polymer science and will most likely be regarded in the future as having had a profound impact on the development of the field. It also offered great potential for the production of new materials such as ultrastrong and durable fibers and films, the preparation of well-defined polymeric surfaces, and the development of new field-responsive polymeric materials for electrical, optical, or magnetic technologies.

Two decades after this important discovery, *Liquid Crystalline Polymers* offers the first opportunity for the scientific community to learn about some of the advances that have been made in the field, including the discovery three decades ago of the synthetic lyotropic systems, in which polymer solutions self-order into liquid crystals. This development led to formulation of the organic material known as Kevlar, which is used to make bulletproof vests and fibers that can have greater strength-to-density values than steel. Donald and Windle begin with a brief history of liquid crystals and liquid crystalline polymers. This chapter's closing statement identifying liquid crystallinity as a form of orientational self-assembly that can be controlled by external fields captures much of the essence of liquid crystallinity's importance for polymeric materials. This is in fact a good reason to have treated in greater depth the subject of electric, magnetic, and surface field alignment of liquid crystalline polymers. The possibility of aligning macromolecules in fields other than mechanical fields is, after all, a unique property of this type of polymer, and the book's omission of some of the key references and discoveries in this area is unfortunate. The introductory chapter is followed by an alphabetical glossary of terminology and concepts, covering both liquid crystals and polymer science. Such a feature is valuable in this era of interdisciplinary science; this chapter will be especially useful to those with limited knowledge of polymer science. The reader is referred to specialized books on liquid crystals for a more complete description of basic concepts such as the classification of the smectic phases.

Over the past two decades polymer scientists have concentrated on two distinct families of liquid crystalline polymers: main-chain and side-chain systems. In main-chain systems the elongated molecular segments that lead to liquid crystallinity are part of the polymeric backbone. In the architecture of side-chain systems, on the other hand, these rigid units are bonded to a flexible backbone through a spacer, forming comb polymers with self-ordering teeth. Donald and Windle treat main-chain systems in greater detail than side-chain systems and clearly convey our current understanding of factors that stabilize the liquid crystalline, as opposed to the isotropic, state of polymeric backbones. Especially well presented are the importance of the chain's persistence length and its directional attractive forces in the stability of polymeric liquid crystalline phases, and the molecular tools discovered by polymer chemists to depress the melting points and isotropization transitions of these materials. A table is presented that contains persistence-length data for various polymers, including some that are nonmesogenic—that is, that do not self-organize into liquid crystalline phases. The phase diagrams of lyotropic polymers—polymers that form liquid crystalline phases in solution beyond a critical concentration—are described in detail.

Theories that predict the physical behavior of liquid crystalline polymers of main-chain and side-chain architecture need further development. There have been many efforts over the past few years to address such issues as the effects of molar mass polydispersity, the semiflexibility of polymer chains, and the role of anisotropic attractive forces. Two important classical contributions are described in detail in the book: the steric lattice theory developed by Flory, relevant to main-chain systems, and the Maier-Saupe mean field theory of liquid crystals.

One chapter is devoted to polymeric analogs to the Friedelian classes of liquid crystals (nematic, cholesteric, and smectic). The macromolecular nature of mesogens or the attachment of mesogens to macromolecules introduces complications that make their classification in the Friede-



Transmission x-ray diffraction pattern of a liquid crystalline copolyester of intermediate molecular weight with a degree of polymerization of 25, cooled in a field of 1.2 T oriented vertically. [From *Liquid Crystalline Polymers*]