universe the odds are that you will find yourself consulting this book.

Hard results from all the work described in this book are rare: the big news so far is that particle physicists seem to be able to provide initial conditions for cosmology that meet what astronomers generally think they want without undue forcing of the particle physicists' theory. Indeed I sometimes have the feeling of taking part in a vaudeville skit: "You want a tuck taken in the waist? We'll take a tuck. You want massive weakly interacting particles? We have a rack full. You want an effective potential for inflation with a shallow slope? We have several possibilities." This is a lot of activity to be fed by the thin gruel of theory and negative observational results, with no prediction and experimental verification of the sort that, according to the usual rules of evidence in physics, would lead us to think we are surely on the right track of the physics of the universe at $z > 10^{10}$. There are prospects: magnetic monopoles may yet be found; calorimetric detectors may demonstrate the existence of massive weakly interacting particles; scans of the sky brightness at centimeter wavelengths may reveal the presence of cosmic strings. If any of this happens the work will have paid off in a very big way.

The editors argue that we ought to take this possibility seriously, that theoretical physics led us in the right direction during the first 50 years of modern cosmology and may very well do so again. I think they are right, for when people have been motivated to work hard on a problem we usually see results, albeit not always what was intended. A lot of people are working very hard on the physics of the early universe, as witness the fact that this book fills 600 pages. And it will be fun to see in 20 years' time how the results compare to the ideas in this volume.

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Psychology and Neuroscience

Mind and Brain. Dialogues in Cognitive Neuroscience. JOSEPH E. LEDOUX and WILLIAM HIRST, Eds. Cambridge University Press, New York, 1986. x, 449 pp., illus. $54.50.

A specter is haunting neuroscience. It is the specter of cognition, of higher-level influences that can no longer be ignored. These influences are generating a revolution in the neurosciences, motivating systematic attempts at interaction between neurobiologists and cognitive psychologists.

The editors of this book have structured such an interaction around four areas: perception, attention, memory, and emotion. In each area a psychology chapter is followed by a neurobiology chapter. Each author then comments on the other's contribution. Finally they reply to one another's comments, completing a formalized conversation in print. In this format the contributors talk to each other, rather than past each other. The result combines the breadth of many authors with the structure of a monograph.

With its innovative format and ambitious goal the book is an experiment, as the editors point out. Their conclusion that psychology and neurobiology have something to offer one another is clear at the outset, for they admit that they have stacked the deck by their choice of topics and contributors. The book provides more than just reviews from each discipline: both sets of contributors write with an eye toward interpreting their field in terms of what is relevant to the other. The results magnify both strengths and problems of the interactions.

The emotion section illustrates several characteristics of the dialogue. The book shows that each field has a slightly outdated and distorted view of the other. Ross Buck, in his otherwise excellent psychological chapter, swallows whole exaggerated overgeneralizations about left-right hemispheric differences, discussing the hemispheres as if they had independent little half-personalities. Joseph LeDoux, the insightful neurobiologist of this section, is more circumspect about hemispheric differences but accepts at face value Neal Miller's early report of instrumental conditioning in the autonomic system. The result has proven impossible to replicate, and even Miller now doubts that such effects exist. LeDoux also accepts Wilder Penfield's reports of "reexperienced memories" elicited by brain stimulation. Subsequent work has shown that the phenomenon occurs only in epileptics and even there has proven difficult to validate.

The memory section directly attacks conflicts between cognitive psychology and neuroscience, with Daniel Schacter emphasizing psychological problems that neuroscience generally ignores. According to cognitive psychologists, we remember only a filtered version of experience. Neuroscience until now has assumed a trivial encoding rule, that a signal passing through a synapse should pass through more easily the next time. Gabriel *et al.* in their chapter on the neurobiology of memory recognize that assuming such an encoding rule is a "leap of faith." Psychologists are insisting that a simple encoding rule is not enough: remembered information is highly preprocessed and linked both with the context and with other information before it is stored.

In general one can distinguish between a mechanism, a physical substrate for memory, and the code that gives the substrate meaning. Ink on paper is a mechanism, for example, while the English language is a code. Is the mechanism of memory the growth of dendritic spines, or strengthened synapses, or something else? Is the code a simple increase in nerve-spike frequency, a recruitment of new channels, or something else? The dilemma is that without the code we won't recognize the mechanism, and without the mechanism we cannot study the physical instantiation of the code.

Schacter also differentiates three kinds of interdisciplinary relationships: collateral, complementary, and convergent. Collateral relations cannot be mapped onto one another; for instance, presynaptic versus postsynaptic actions have no parallel in psychology. Collateral relations also appear in Richard Marrocco's review of peripheral anatomy. Like other anatomical reviews by neurobiologist contributors, it is a reductionist's promissory note for eventual relevance to cognition. The psychologist reads patiently, hoping that the anatomy will someday contribute to the construction of psychological theories. Complementary relations occur when one level supplements the other, and convergent relations exist when the two disciplines coordinate their agendas in attacking a common problem, such as the issue of the number of distinct forms of memory.

Some conflicts arise because psychology and neurobiology have different agendas for the same data. James Hoffman's psychology of perception chapter reviews a neuron that seems to detect a monkey's hand, the neuron with perhaps the best public relations of all time (neurobiologists would hesitate to accept any result based on just one neuron). This cell became famous in psychology because it filled a theoretical need for detectors of psychologically meaningful states, though a single cell's output is always ambiguous. In the real world, as opposed to the laboratory, a neuron almost never fires at its maximal rate. Did it fire less because the stimulus was slightly wrong in orientation, or contrast, or motion? Only comparison with the firing of other neurons can resolve the question, so that the idea of a single cell as a detector is obsolete. The psychologist takes the neuroscientist's records of what a neuron is looking at and tries to infer what the neuron is looking for.

Though the editors conceived their book as a contact between separate disciplines, the fields can also be interpreted as specializations along a continuum. The phrase "cog-

nitive neuroscience" suggests a new approach to the old puzzles of mind and brain. Problems of mind at the cognitive level become problems of brain for neurobiology. A quantitative transition from one level to another replaces the old mind-brain dichotomy. In this interpretation, experience becomes a functional adjunct to some of the higher levels of behavioral integration.

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Yeasts

Yeast Cell Biology. JAMES HICKS, Ed. Liss, New York, 1986. xxii, 671 pp., illus. $125. UCLA Symposia on Molecular and Cellular Biology, New Series, vol. 33. From a symposium, Keystone, CO, April 1985.

During the past 10 years research on yeasts has undergone rapid progress on several fronts. This progress stems from the development of molecular genetic techniques for isolating genes and for changing any chosen nucleotide in the yeast genome. The phenotypic effects of mutations thus produced, including even lethal ones, can be determined readily by various biochemical, immunochemical, and genetic selection techniques. Data collection is also facilitated by a short (two hours) life cycle and simple growth conditions. In addition, improvements in cellular fraction techniques now allow nearly all types of organelles to be purified in large quantities.

This collection of papers provides a clear indication that our understanding of cell biology at the molecular level will expand at an explosive rate in the next decade. It offers glimpses into several areas of cell biology in which yeasts, primarily *Saccharomyces cerevisiae*, are being used to dissect fundamental cellular processes. One cannot help sensing the aura of excitement that surrounds this research.

Topics covered include the cytoskeleton, control of the cell cycle, DNA replication and chromosome structure, nuclear organization, macromolecular traffic (proteins localized in the nucleus; secretion, endocytosis, and the cell surface; import of proteins into mitochondria), and models for development.

Several contributions provide sufficient background material to allow beginning and advanced researchers whose expertise lies elsewhere to comprehend not only the experimental details presented but also how they fit into the larger scheme of the cell. Papers in this vein include those by Pillus and Solomon and Thomas *et al.* on the cytoskeleton, by Ng *et al.* on centromeres, by Guthrie *et al.* on small RNA's and RNA processing, and by Gross *et al.* on chromatin structure and gene expression. The final chapter, by Herskowitz, on yeast as a model for development, lucidly describes how yeast cells "make it possible to learn about several important areas of cell biology, in particular, the cell cycle and growth control, protein localization, chromosome structure, meiosis, and morphogenesis."

This book should appeal to a wide audience including graduate students and senior researchers who want to survey selected areas of cell biology. Although one can profitably read a few papers, I highly recommend reading the entire book because it provides a global view of current and future research directions in cell biology.

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