the interrelationships of metabolic reactions is emphasized by the presentation of a model of the pathways of polysaccharide synthesis and degradation which can be manipulated by computer. By arbitrarily varying enzyme activity or substrate availability the model can indicate the consequences of such changes on the concentration of cellulose, glycogen, and mucopolysaccharide.

This would appear to be an effective new approach to the sometimes bewildering complexity observed in eukaryotic differentiation, if there were convincing evidence that the model accurately predicts or even describes the changing biochemistry of the cells. Unfortunately, accurate measurements of metabolic rates in vivo are difficult to make. In this presentation, the pitfalls inherent in the measurements are not critically considered. Data supportive of the present model are presented but conflicting results are generally not discussed. To suggest that the physiological steps necessary and sufficient for differentiation are known seems premature, even in as simple a system as *Dictyostelium*. Nevertheless, this book succeeds in reminding us that ultimately we must consider all of the biochemical processes involving both small molecules and macromolecules in the sequence of events from the genes which define the differentiation to the final molecules which give it shape.

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Neuroendocrinology

Steroid Hormones and Brain Function. Proceedings of a conference, Los Angeles, May 1970. CHARLES H. SAWYER and ROGER A. GORSKI, Eds. University of California Press, Berkeley, 1972. xiv, 388 pp. + plates. $30. UCLA Forum in Medical Sciences, No. 15.

The decision of Sawyer and Gorski to organize a conference bringing together the varied research findings of 30 scientists approaching the subject of relationships between the endocrine and the central nervous systems from different disciplines, concerns, and methodologies is itself to be applauded. The proceedings of that conference, now consolidated in book form, offer a valuable synopsis of the work accomplished in this area since the 1963 conference on "The Brain and Gonadal Function." The specific research findings are preceded by an introductory chapter written by Gorski, on "progress, principles, and problems," in which he presents a brief review of recent advances in neuroendocrinology, and the material is summarized in a concluding chapter prepared by Davidson. Rather than being a loose collection of individual research papers, the conference proceedings, and the book, reflect the efforts of Sawyer and Gorski to develop and follow a central theme—how steroid hormones alter brain function—at four levels of inquiry: intracellular, intercellular, systemic, and organismal.

In addition to providing a framework in which to view the research reported, the editors have reproduced the question-and-answer session at the end of each talk, thus preserving the dynamic spirit of the conference without sacrificing coherent and substantive presentation of material.

The effects of steroid hormones on brain function have been explored primarily in terms of electrophysiological and behavioral parameters, although some morphologic, biochemical, and clinical aspects also have been considered. Implicit in the research reported is the dual nature of hormonal action on the central nervous system, that is, regulatory as well as organizational, the latter being predominant during the developmental period. Thus, the effects of steroid hormones on the brain have been investigated during certain "crisis" growth periods—fetal, perinatal, and pubertal.

The mechanisms of steroid feedback and brain-pituitary function have been elaborated in several species—rat, cat, rabbit, monkey, and man—and although, as is reiterated throughout the book, the existence of hypothalamic releasing factors now has been firmly established, the possibility of a direct feedback of steroid hormones on the pituitary has not been eliminated; in fact, it is a primary concern of several of the investigators participating in the conference.

The physiology of hormone receptors and the biochemistry of hormone-binding to cell nuclei and cytoplasmic macromolecules, considered in several chapters, represent one of the most recent directions of research in this area. In fact, more attention to this aspect of the subject would have enhanced the book, inasmuch as hormonal influences on brain development and function have been well documented; our current concern is to seek, rather, the specific mechanisms of action at the cellular and molecular level by which these effects are produced. Such a criticism, however, may reflect the vantage point of one speaking three years later, when much has been added to our understanding of the subject. In any case, the lack should not detract from the excellence of this volume, which is a fine reference text not only for the neuroendocrinologist but for all of those working in endocrinology, neurology, and psychology whose specific research interests are in the relationships between hormones and the central nervous system at different age periods.

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The Dirac Story

Aspects of Quantum Theory. ABDUS SALAM and E. P. WIGNER, Eds. Cambridge University Press, New York, 1972. xvi, 268 pp., illus. $23.50.

This is a collection of essays dedicated to P. A. M. Dirac on the occasion of his 70th birthday. The Dirac story is on the whole a success story. Nevertheless two of the most substantial articles here are concerned with two "suggestions of Professor Dirac that nature does not seem to have used." They are by Amaldi and Cabibbo, on the so far unsuccessful search for the magnetic monopole, and by Dyson, on the lack of evidence so far for any time variation of fundamental physical constants. But several of Dirac's suggestions *have* been used by nature, and several more at least by theoretical physicists. These are very properly celebrated here: the Poisson bracket and quantum mechanics (by Lanczos), the bra and ket formalism (Jauch), the delta function (Schwartz), the quantization of radiation (Jost), the Fermi-Dirac statistics (Peierls), the Dirac wave equation (Wightman), the classical radiation reaction (Pais), and the indefinite metric (Heisenberg). The tone is not entirely one of piety. Thus Peierls mentions an occasion when Dirac was "somewhat naive" (conjecturing Fermi-Dirac statistics for gas molecules); Schwartz recalls the horror of mathematicians at Dirac's delta function; and Jauch argues at some length against Dirac's view that his formalism could be presented with mathematical rigor "only in a cumbersome way which would tend

to obscure the argument." On points like these, and others, it would have been good to hear from the subject himself.

There is an excellent collection of essays, *Albert Einstein: Philosopher-Scientist* (P. A. Schilpp, Ed.), the value of which is much enhanced by the final article, which is Einstein's reply. It is true that Dirac is a less controversial figure than Einstein; his work has not had the same impact on the world at large, and he is himself legendary for his silences rather than his interventions. Yet he is said to have some interesting views (for example, on the futility of mathematical rigor in physical theory, that the fundamental importance of group theory has been exaggerated, that Bohr's complementarity principle added little to quantum theory, that indeterminism is a defect of contemporary physical theory that one day may be eliminated). Perhaps an invitation to conclude this volume by a review of it would have tempted him out of his habitual reticence. By the way, a theory is given here of this reticence, in one of the several biographical and anecdotal contributions. Mehra tells how Dirac's father, who had been Swiss, ruled that at home French was to be spoken. It seems that Dirac was not very good at French, and so became early a man of few words.

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Tunneling

Superconductive Tunnelling and Applications. L. SOLYMAR. Wiley-Interscience, New York, 1972. xii, 460 pp., illus. $22.95.

The Josephson Effect in Superconductive Tunneling Structures. I. O. KULIK and I. K. YANSON. Translated from the Russian edition (Moscow, 1970) by P. Gluck. Israel Program for Scientific Translations, Jerusalem, 1972 (U.S. distributor, Halsted [Wiley], New York). x, 182 pp., illus. $20.

The introduction of newcomers to the subject of superconductive tunneling will be relatively painless now that these two authoritative books have appeared. Before identifying the appropriate audiences for these books, it is perhaps worthwhile at least to define the words in their titles. "Superconductive tunneling" denotes either the tunneling of condensed pairs of electrons between weakly coupled superconductors (Josephson tunneling) or the tunneling of normal electrons between a superconductor and a normal metal (normal electron tunneling). Josephson tunneling occupies all of Kulik and Yanson's book and half of Solymar's and normal electron tunneling the remainder of Solymar's. In normal electron tunneling the tunneling current depends in detail upon the phononic and electronic properties of the metals used in the tunneling pair; hence such tunneling can be used as a diagnostic probe of various physical properties of a metal. On the other hand, Josephson tunneling is, roughly speaking, independent of the physical parameters of the pair of superconductors and depends only upon the existence of a well-defined superconducting order parameter. The physics of the Josephson effect is elegantly simple and well understood. The utility, present and promised, of the Josephson effect lies in device applications, such as microwave generators, mixers, and detectors and incredibly sensitive voltmeters and magnetometers. Solymar has responded by pitching his book at a mathematical level appropriate for a developmental engineer or applied physicist rather than a many-body theorist.

Solymar's book is richly pedagogical, uniform in depth of mathematical treatment, and extremely well organized. It is self-contained in the sense of supplying the basic and background material required of, for example, a device engineer who knows nothing about superconductivity but plans to work on applications of the Josephson effect. The reader who has a definite commitment to the investigation or use of superconductive tunneling will greatly appreciate Solymar's thorough referencing of the existing literature (964 references). Solymar's high level of scholarship is breached at only one point, where he refers to the quantum interference effect discovered by Jaklevic, Lambe, Mercereau, and Silver as the "Mercereau effect" and, indeed, gives that title to one chapter. This is hardly judicious; nor can it be excused, as Solymar implicitly requests, merely because P. W. Anderson made a similar judgment earlier.

Kulik and Yanson's book, like Solymar's, is authoritative, comprehensive, and well organized. It differs considerably from Solymar's in the level of presentation. For example, chapter 1 contains a full-blown treatment of the many-body theory of the Josephson effect, and thus would be incomprehensible to a large fraction of the readership mainly interested in the second half of the book, which deals, as does Solymar's, with the various observed effects, sample preparation, and device applications.

The device engineer or solid state physicist working with Josephson tunneling cannot afford not to have both these books on his shelf. Solymar's will find additional markets as a reference book for solid state physicists involved with normal electron tunneling and as a textbook for specialized engineering courses on Josephson-effect devices. Both books should be available for reference to students taking graduate-level solid state or superconductivity courses. Solymar's, because of its level, is appropriate as well for final-year undergraduates.

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Effects of the Sun

Solar-Terrestrial Physics. An Account of the Wave and Particle Radiations from the Quiet and the Active Sun, and of the Consequent Terrestrial Phenomena. SYUN-ICHI AKASOFU and SYDNEY CHAPMAN. Oxford University Press, New York, 1972. xxiv, 902 pp., illus., $80. International Series of Monographs on Physics.

Geomagnetism, the two-volume work by Sydney Chapman and Julius Bartels, served as the basic reference and source book on solar-terrestrial relations up to the International Geophysical Year (1958), which initiated the era of artificial satellites and space probes. *Solar-Terrestrial Physics* is intended as its sequel, carrying the subject through 1971 and thus through the first decade of space research. Because of the volume of new material and the breadth of the field, it is an ambitious undertaking for two authors. The authors have made prolific and significant contributions to nearly every aspect of the field, and in my opinion they have succeeded in this latest undertaking. The magnitude of the effort this book represents is illustrated by the time required for preparation. It was begun in 1964, final compilation started in the summer of 1969, and it was completed in February 1971.

The work is effectively a handbook on all topics associated with the relations between the sun and the earth. In addition to the usual or expected topics included under this heading, the