in the Soviet context his apparently general remarks are highly charged; financial flexibility, receptiveness to new ideas, and speed in making the necessary resources available are held to be necessary conditions for successful innovation. A plea for nonconformism in science is also advanced, and the Swedish philosopher Tornebohm's dictum that "little grains of sand are a great irritation to oysters but they help to create the pearls" is quoted with qualified approval. On the foreign front, Sheinin is clearly struck by the successful Japanese strategy of assimilating Western technology on a substantial scale and notes with interest the recent leap forward in Japanese domestic R & D spending. Japanese experience is thus depicted as a model that may contain many relevant features for the U.S.S.R. There is, however, one unresolved contradiction in Sheinin's account. On the one hand he believes that American technological relationships with other advanced capitalist countries are essentially exploitative ones because the most creative brains in these countries are harnessed to American objectives. On the other hand we find that in recent years there has been a growing challenge to the leading position of the United States in world markets for technology-intensive goods. This phenomenon suggests that the benefits of direct U.S. involvement in Western economies are underestimated by the author. It could well be that this form of technology transfer, which is ruled out by the U.S.S.R., is more effective than, for example, formal cooperative links within the Council for Mutual Economic Assistance.

Although Sheinin is constrained to present a favorable account of Soviet "reality," the resulting picture does not lack subtlety or objectivity. He sees clearly that, whereas the Soviet Union possesses the advantages of centralized priorities, national planning, and elimination of wasteful duplication, the spontaneity of innovation in Western countries, the responsiveness to consumer demand, and decentralized decision-making are also worthy of serious attention. Between these two extremes performance may be enhanced by pragmatic reforms that do not threaten fundamental principles. These are fair judgments about complex social processes that are not yet fully understood in any country.

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Genetics

Genetic Interaction and Gene Transfer. Papers from a symposium, Upton, N.Y., May 1977. CARL W. ANDERSON, Ed. Brookhaven National Laboratory Biology Department, Upton, N.Y., 1978 (available from the National Technical Information Service, Springfield, Va.). xvi, 378 pp., illus. Paper, $13; microfiche, $3. Brookhaven Symposium in Biology No. 29.

This volume is one of the few recent collections of work on the transfer of foreign genetic information into eukaryotic cells. The editor states in the introduction that it is impossible to give an exhaustive or even an up-to-date treatment of the subject in the symposium format, a disclaimer that is particularly appropriate given the explosion of information on the subject. The published proceedings, therefore, are of more interest for the review material they provide than as a source of current information.

The book is divided into five sections. The first, which deals with natural genetic interactions, includes interesting discussions by Attardi *et al.* of mitochondrial gene control, by Schell and Van Montagu of the important subject of Ti plasmids and their role in crown gall disease, and by Bogorad *et al.* of the regulation of expression of genes for ribosomal proteins and RNA's of the green alga *Chlamydomonas reinhardi*. There is a concise review by Diener of the potato spindle tuber viroid, including a speculative but useful discussion, based on the Britten-Davidson model of gene regulation, of the possible role of viroids as activator RNA's. There is an interesting but somewhat out-of-place discussion by Siddiqui *et al.* of the RNA-dependent induction of heart-specific tissues in the duck blastoderm, demonstrating a probable regulatory role for RNA in this developmental system.

The second and third sections deal with methods of introducing foreign genetic information into eukaryotic cells, beginning with a description by Mintz of the powerful teratocarcinoma system for the introduction of specific mutations into mice. A series of somewhat repetitive papers dealing with chromosome-mediated gene transfer is presented by Ruddle and Fournier, McBride and Athwal, and Degnen *et al.*, and there is a paper by Spandidos and Siminovitch dealing with transfer of dominant markers, consecutive enzymes in the folate pathway, and anchorage independence. Very recent reports from the Spandidos and Siminovitch laboratory indicate that the results may not be reproducible, and all the recently reported results dealing with these systems, including those presented here, are being reevaluated. It does, however, seem clear from reports from a number of laboratories that chromosomal gene transfer results in both unstable (abortive) and stable transformation of cells carrying genetic markers such as hypoxanthine phosphoribosyl transferase or thymidine kinase deficiency.

The use of naked DNA for transformation is discussed by Mishra in the system in *Neurospora* involving inositol-requiring mutants and by Coon and Ho for the transfer of chloramphenicol resistance to 3T3 cells by mitochondrial DNA. These represent the most solid studies of DNA transformation in a field long troubled by irreproducible results. There is a somewhat cursory review by Lacks of DNA uptake by *Diplococcus pneumoniae*, but there is little or no discussion anywhere of the mechanisms of DNA uptake by eukaryotic cells or of the nature of competence in eukaryotic cells.

Graessmann *et al.* give brief glimpses of the use of microinjection into oocytes, fertilized eggs, and cultured cells to study the control of gene expression of the SV40 genome, and Celis describes the intriguing but apparently inefficient use of microinjection of suppressor transfer RNA into cultured cells to screen for nonsense mutations. Upcroft *et al.* describe the use of SV40 containing an *Escherichia coli* DNA fragment carrying the suppressor gene Su^{+}III to transform rat cells and demonstrate that the bacterial fragment remains stably integrated, along with the SV40 sequences, in transformed cells.

The last two sections begin with a brief description by Bukhari of transposable elements and insertion sequences, followed by a description by Laten *et al.* of examples of genetic translocation of the yeast SuP_{1-16} gene, a discussion by Novick of translocation mechanisms in E. *coli*, and a discussion by Reanney of the possible adaptive role of DNA translocation, both between various replicons within a cell and between different cells.

A short but difficult and confusing discussion by Hicks and Strathern deals with the genetic rearrangement occurring during interconversion of mating types in yeast. Carbon *et al.* describe the isolation of *E. coli* plasmids carrying cloned yeast DNA and capable of complementing *E. coli* auxotrophs and show that many of the yeast genes function in the prokaryotic environment. Likewise, Kushner *et al.* describe a plasmid carrying *Neurospora crassa* DNA that can

complement a dehydroquinate-hydrolase-deficient *E. coli* mutant.

Lodish *et al.* give a comprehensive review of messenger RNA translation regulation, and Berget and Sharp and Gelinas *et al.* introduce the exciting and immensely important subject of splicing of the late messenger RNA's of adenoviruses, work in which great advances, extending to a growing number of eukaryotic genes, have been made since the symposium.

The symposium lecture by Charles Thomas constitutes a sensible look at the recent history of research and attitudes in genetics. He is clearly not impressed with the prospects of gene therapy and even considers much of the talk about it to be irresponsible. Some of it obviously is, some may not be. The fanciful expectations of today are the reasonable expectations of tomorrow, and the therapeutic use of some genetic techniques will certainly come to pass.

The volume is valuable, generally reads well, and should prove useful as a part of the review literature on genetic transfer into eukaryotic cells.

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Mathematical Physics: Bielefeld Lectures

Many Degrees of Freedom in Field Theory. Proceedings of an institute, Bielefeld, Germany, Aug. 1976. L. STREIT, Ed. Plenum, New York, 1978. viii, 248 pp., illus. $27.50. NATO Advanced Study Institutes Series B, vol. 30.

In 1975–76, the University of Bielefeld sponsored a special year in mathematical physics, emphasizing quantum field theory and statistical mechanics. A lecture series (*Quantum Dynamics: Models and Mathematics*, L. Streit, Ed., Springer-Verlag, 1976) inaugurated the year, and in mid-year these topics formed part of the annual Schladming lectures (*Current Problems in Elementary Particle and Mathematical Physics*, P. Urban, Ed., Springer-Verlag, 1976). A lecture series at the end of the year dealt in part with mathematical physics and in part with multiparticle phenomena at high energy. The proceedings of this last series are reviewed here and in the following review. Altogether, these volumes provide a perspective of the field up to 1976. The entire Bielefeld project and these symposia owe much to the indefatigable Ludwig Streit.

Lectures by J. Fröhlich provide an overview of constructive quantum field theory, starting with the Wightman axioms and their Euclidean counterpart in terms of Schwinger functions. For various models the Schwinger functions are given by a random process, the expectations of which are an infinite-dimensional version of Gibbs averages in statistical mechanics. Formally—rigorously after renormalization and suitable limits—such averages are the imaginary time continuation of the classic Gell-Mann-Low formula in quantum field theory. Fröhlich gives a detailed account of integrability for the Gibbs factor in the $(\theta^4)_2$ theory, avoiding explicit use of hypercontractivity for the free field. A brief sketch of spontaneous symmetry breaking and critical behavior for $(\theta^4)_3$ may be amplified by reference to Fröhlich's Schladming contribution. For an introduction to spontaneous symmetry breaking within the axiomatic framework, there are lectures by R. Streater. Since 1976, however, the thrust of research in field theory has been the extension of this genre of techniques to superrenormalizable gauge field theories.

Two sets of lectures deal with topics of current interest in gauge field theory. K. Pohlmeyer reviews the role played by solitons in classical field theory, with A. Luther's applications to the energy spectrum for the Thirring model which were arrived at by way of the eight-vertex, *XYZ*, Heisenberg, and sine Gordon models; L. O'Raifeartaigh gives an in-depth account of the mathematics surrounding the t'Hooft-Polyakov soliton for the SU(2) Yang-Mills field. Each of these is a worthy supplement to the journal literature. The one other set of lectures related directly to quantum dynamics is by D. Robinson on descriptions of time evolution by means of unbounded derivations in operator algebras. This is a very readable introduction to a rather technical subject that is in danger of burgeoning beyond classical semigroup theory in Banach spaces to a full theory in its own right. For strongly continuous evolutions, a key role is played by the analog of self-adjointness for the derivation.

The remainder of the volume contains shorter comments by J. Tarski on nonstandard analysis, by M. Cassandro and G. Jona-Lasinio on the central limit theorem for Ising models, and by M. Reed on some problems for nonlinear wave equations. Reed's more detailed (1975) Bielefeld lectures appear in his book *Abstract Non-Linear Wave Equations* (Springer-Verlag's Lecture Notes in Mathematics, vol. 507).

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Many Degrees of Freedom in Particle Theory. Proceedings of an institute, Bielefeld, Germany, Aug. 1976. H. SATZ, Ed. Plenum, New York, 1978. viii, 566 pp., illus. $45. NATO Advanced Study Institutes Series B, vol. 31.

The idea of coherent phenomena is old to physics: a system acting as a whole exhibits behavior entirely different from that of its individual components. It is as fundamental as it is old, so it is natural that it finds a place in the modern theory of elementary particles. The present volume of Bielefeld lectures is mainly phenomenological in its review of the rich variety of coherent effects in high energy physics. It thus fails to reflect the theoretical activity in 1976, in particular the development of the role that classical solutions of quantum theories play in the description of coherent nonperturbative quantum effects.

The book is worth reading, however, as a solid, comprehensive preparation for the exciting developments expected in particle physics. The lectures of J. B. Kogut on lattice gauge theories of the strong interactions start with the original ideas of A. M. Polyakov and K. Wilson, which led to the study of quantum field theory by statistical mechanical methods. The lectures continue with the introduction of the Hamiltonian formulation on the lattice, which is then used to estimate the low energy spectrum of the theory. Using block spin techniques with an array processor, Wilson is now in a position to make further estimates of the hadron spectrum. We may thus soon have more detailed calculations with which to evaluate the success of lattice gauge theories.

A paper by H. Fritzsch, "Unified interactions of leptons and quarks," presents a highly articulate overview of present-day weak interaction theories and the connections they may have with the strong and electromagnetic interactions. In particular Fritzsch reviews models for the number of quark and lepton flavors and the relationship between them. In the next two to five years, with the new accelerators PETRA at Deutsches Elektronen-Synchrotron and PEP at Stanford Linear Accelerator Cen-