analogy with alleles increasing mutability, which "hitch rides" from the spread of new favorable mutants to which they are closely linked. Mutator alleles create many mistakes, but each mistake kills only one mutator, whereas a good mutant can spread its mutator right through a population. If Maynard Smith is right, alleles increasing recombination rate affect recombination only in loci very near their own, rather than in the genome as a whole. If correct (and even Maynard Smith is not sure), this view has startling implications for the efficacy of small selective differentials. It does not seem to explain why genes come in many chromosomes.

In sum, this small book about sex bears on fundamental issues in evolutionary theory. If Maynard Smith is right, the availability of suitable mutations must limit evolutionary rate, at least at times: paleontologists dispute this, citing the rapid evolution of elephants, with their long generations. If he is right, genetic variation must be largely additive, and very small selective differentials must be effective: both are topics of heated and emotional debate. For all its weighty implications, this book is pleasant, even charming, rich with interesting asides, admirable for its balanced perspective.

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Nuclear Transplantation

Cloning. Nuclear Transplantation in Amphibia. A Critique of Results Obtained with the Technique, to Which Is Added a Discourse on the Methods of the Craft. ROBERT GILMORE MCKINNELL. University of Minnesota Press, Minneapolis, 1978. xii, 320 pp., illus. $22.50.

The title of this book may capture the public fancy, but the subtitle more accurately describes its contents. Cloning is one use of nuclear transplantation, but there are many others. Nuclear transplants have proved valuable in the analysis of histocompatibility reactions, in distinguishing genetic from epigenetic determinants of sex differentiation, in studies of pigmentation patterns and serum proteins, and in the examination of nucleocytoplasmic interactions within and between species. In addition, polyploid animals have been produced by nuclear transplantation. These uses, however, are not the central subject of this book. Rather, the book is primarily concerned with whether the genomes of differentiated cells are equivalent to one another and whether a nucleus from a differentiated cell can replace the zygote nucleus and lead to normal development. This is one of the major questions of developmental biology, and has been for many decades. Although the answer is not in yet, in recent years the notion that the nuclei of differentiated cells are genetically equivalent has been promulgated both within the scientific community and to the lay public. Moreover, it is commonly believed that the implantation of differentiated nuclei into enucleated eggs leads frequently to perfectly normal development. This is not the case. The cloning of adults is not practical at the present time.

McKinnell carefully examines all of the evidence relevant to cloning in Amphibia and provides the reader with a well-balanced account. His critical, scholarly review of the evidence raises questions that everyone, particularly developmental biologists, should consider seriously. With two or three possible exceptions, the results he describes of nuclear implantation into enucleated eggs demonstrate that adult nuclei become irreversibly differentiated. All investigators agree that, in general, the older the cell from which a nucleus is taken the smaller the probability that normal development will ensue after the nucleus is transplanted into an enucleated egg. This is true for *Rana pipiens* and for *Xenopus*, the two principal amphibians used in these experiments. Moreover, as McKinnell properly brings to attention, the particular spectrum of abnormalities produced in embryos developing after nuclear transplantation is related to the source of the nucleus, whether from endodermal, mesodermal, or ectodermal cells. Recycling the nuclei of such abnormal embryos through new generations of replication, by transplantation into eggs, generally results in a reappearance of a similar syndrome of abnormalities. Such results clearly suggest that during development the nuclei become restricted in the variety of gene programs that can be expressed. Nevertheless, the number of cell types that can be produced after transplantation of such nuclei is impressive and much greater than the original cell was destined to produce.

McKinnell examines in detail the specific examples or exceptions that seem to indicate that the nuclei from differentiated cells retain their totipotency. He points out that in no case has a truly adult nucleus taken from an adult animal and transplanted into an enucleated egg ever resulted in the development of a normal adult individual. However, nuclei from truly adult cells after a period of growth in tissue culture or after several cycles of replication in eggs have been successfully transplanted and have given rise to a few adults. More often, though, even these nuclei give rise to abnormal development.

McKinnell properly points out that generalizations in biology are usually based on the mass of evidence rather than on the few exceptions, but in the case of the equivalence of the nuclei of adult cells the exceptions seem to predominate in the thinking of both the public and most developmental biologists. The overwhelming mass of evidence suggests to this reviewer, as it does to McKinnell, that nuclei do become irreversibly differentiated during the development of an organism and that they are not able to replace the zygote nucleus when transplanted into an egg. The few exceptions seem to be just that—exceptions. It is quite possible that a few cell types or a few cells in an adult may retain their totipotency, or that under unusual conditions the differentiated state of the genome can be reversed, but such reversal is rare. Its rarity, even after many cycles of chromosomal replication, implies that the DNA itself is changed during cell differentiation.

Although it is not discussed by McKinnell, an increasing amount of evidence suggests that chromosomes are not so fixed in structure as we once believed. Consider the evidence concerning the differential replication of parts of the DNA during polytenization of *Drosophila* chromosomes and the changes in the heterochromatin of *Cyclops* chromosomes, the existence of "jumping genes," the well-studied insertion of viral DNA into chromosomes, the production of antibody protein molecules involving the sequential reading of DNA occupying different sites in the genome, and the existence of nontranslated DNA inserts into structural genes. This evidence all points to a modifiability of chromosome structure. Perhaps programmed changes in structure also occur as the basic change leading to stable cell differentiation, with parts of the genome permanently on and other parts permanently off. Nothing but the DNA seems to be left to account for the failure of replicating transplanted nuclei to bring about normal development. All molecules associated with the DNA in the chromosomes would have been diluted out during replication after transplantation of differentiated nuclei. Only

the DNA replicates. If abnormalities in development persist, the responsibility must be placed on the DNA itself.

By drawing attention to the results of nuclear transplantation in a well-balanced critical presentation, and by providing comprehensive coverage of the relevant literature, McKinnell has done a great service for the biological community. In addition, he has provided in a series of appendixes very useful data for anyone wishing to undertake nuclear transplantation in Amphibia. He lists the sources of the animals, the tools and techniques, and the composition of the necessary media. Careful study of this book will profit all biologists and is indispensable to graduate students and others who plan to make use of nuclear transplantation for the investigation of any of the many problems approachable with this technique.

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Osmotic Regulation in Animals

Osmotic and Volume Regulation. Proceedings of a symposium, Copenhagen, June 1977. C. BARKER JØRGENSEN and ERIK SKADHAUGE, Eds. Munksgaard, Copenhagen, and Academic Press, New York, 1978. 512 pp., illus. $49. Alfred Benzon Symposium XI.

The editors of this volume write in their preface that diversification of research impairs communication among specialists in the physiological sciences. In organizing the symposium on which the volume is based, it was the expressed aim of Jørgensen and Skadhauge to promote synthesis by uniting established investigators in the conceptually allied but practically disparate branches of animal physiology concerned with osmotic and volume regulation.

The immediate result of this effort is a collection of some two dozen papers, most of which contain information that has been published elsewhere. The papers are organized into seven sections that adequately represent the broad scope of this subject, at least with respect to vertebrates. The first section deals with the environmental physiology of extracellular fluid volume regulation. It is followed by sections considering the control of drinking, the role of the kidney, the involvement of hormones, and nonrenal mechanisms of water and salt balance. The final two sections present a rather cohesive treatment of volume regulation at the cellular level, with topics ranging from red blood cells to euryhaline invertebrate tissues. Happily, the editors have chosen to print the informal discussions that followed each presentation, and this adds measurably to the utility of this collection.

The participants were given considerable latitude in how they approached their topics, and consequently some of the papers are detailed discussions of very specific topics whereas others serve as brief state-of-the-art messages. For example, the section dealing with volume regulation via antidiuretic hormone is quite involved. Fortunately for the nonspecialist, the concluding paper in this section, by A. C. Guyton *et al.*, nicely shows the utility of a systems analysis approach in integrating the complexities of control evidenced in the preceding papers. Quite in contrast, the section considering the role of the vertebrate kidney is an excellent overview of the comparative physiology of this organ. The introductory remarks by B. Schmidt-Nielsen serve as an informative backdrop for a paper by W. H. Dantzler on avian and reptilian renal mechanisms and one by H. Stolte and Schmidt-Nielsen on renal function in cyclostomes, elasmobranchs, and reptiles.

The symposium provided a forum for the presentation of new ideas and the reinterpretation of older views. Thus, a paper by B. Andersson and another by P. Bie present evidence that contradicts various elements of the generally accepted osmoreceptor model for the control of mammalian water balance. Lively, albeit lengthy, discussions follow these challenges to the classic Verney model.

The collection also contains two papers of a speculative nature. L. B. Kirschner considers the significance in vivo of the external mucus layer covering the gills and skin of aquatic animals, and E. H. Larsen provides a much-needed quantitative treatment of the control of volume and ion content of epithelial tissues. Both papers should be quite useful in future studies for they provide verifiable models of important phenomena in osmotic regulation in animals.

On the whole, the volume is too heterogeneous for those seeking an overview of osmotic and volume regulation in animals. It should, however, command the attention of those specialists it hopes to unite, and in this respect the experiment is a success, particularly if the spirit of this symposium can be carried beyond the pages of this volume.

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Marshland Ecology

Freshwater Wetlands. Ecological Processes and Management Potential. Papers from a conference, New Brunswick, N.J., Feb. 1977. RALPH E. GOOD, DENNIS F. WHIGHAM, ROBERT L. SIMPSON, and CRAWFORD G. JACKSON, JR., Eds. Academic Press, New York, 1978. xviii, 378 pp., illus. $17.50.

Probably no land resource has been more ruthlessly exploited than our nation's wetlands. Nearly half the wetlands have been destroyed, and the destruction continues at an estimated rate of 0.5 to 1 percent annually, according to Jack McCormick, a contributor to this volume. Continued destruction is the pattern even with two Executive Orders (No. 11,990, Protection of Wetland, and No. 11,988, Floodplain Management, both issued 24 May 1977). Although some states have passed wetlands protection legislation, there is still cause for national concern. Therefore, this book, the proceedings of a symposium whose objective was to summarize knowledge of the ecology of freshwater marshes and to highlight research needs, is most timely. The 20-some contributions are divided into sections covering primary production, decomposition, nutrient dynamics, and management potentials. Each section is followed by a succinct summary and recommendations.

Data presented in the volume indicate that herbaceous-plant-dominated emergent wetlands (marshes) are, like tidal wetlands, among the most productive ecosystems in the world. Whigham and his colleagues provide an excellent tabular summary for some 20 species. Average peak estimates of annual aboveground standing crops range from 566 to 2311 grams per square meter and compare closely with estimates from salt marshes. Even these figures are underestimates, for there are growing-season losses that, depending on sampling techniques, may be missed and below-surface production, which may be considerable in emergent forms, is not included. In fact, belowground standing crops in prairie marshes can reach nearly 2000 grams per square meter. These prairie wetlands, where 18-fold production changes can occur over a period of five to 20 years, are also among the most dynamic wetland systems. Studies of sedge wetlands by J. M. Bernard and E. Gorham suggest that it is vital to know the life history of the species being studied—a fundamental aspect sometimes overlooked by ecologists preoccupied with computers or statistics.

Fluctuating water tables typical of