manipulations with somatic cells, fascinating though they are, add very significantly to what can be achieved by more conventional methods of plant breeding.

The first and last contributions to the Symposium are rather more lightweight. Dean Miller's concluding paper on " Natural selection and adaptive resemblances " is a pleasant and easy introduction to the subject. Erwin Chargaff's opening essay—" A few remarks on the impact of biochemistry of genetics "—is odd. It promises something of interest but what we get is more of the author's usual bitter sarcasm at the expense of molecular biology. One wonders why he came.

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THE CONTROL OF GENE EXPRESSION IN ANIMAL DEVELOPMENT. J. B. Gurdon. Clarendon Press: Oxford University Press. Pp. 160+29 figures. £3·50 (hard cover), £1·25 (paperback).

" How is gene expression controlled, and what determines the distribution of materials in and among cells? These are the two most important questions in animal development." Few biologists will disagree with these opening statements to John Gurdon's recent book. This book originated from the Dunham Lectures delivered in 1971 to the Harvard Medical School and is mainly concerned with the first of these two questions. The book can be highly recommended to all biologists with an interest in developmental biology. Not only does it give an authoritative account of Gurdon's own work over the last 15 years but it does so in a very readable and attractive way.

The three main chapters of the book cover, in turn, the three main levels at which the control of gene expression may be exercised: differential DNA replication or gene mutation, differential translation of mRNAs and differential gene transcription. It is important to note what this book is not, it is not a textbook of modern developmental biology nor even a comprehensive review of current research in this rapidly expanding field. It is a very stimulating discussion of the contribution of various techniques, especially those involving nuclear transplantation and mRNA injection into oocytes, to the experimental analysis of certain aspects of development. The emphasis is on experimental rigour though never to the point of pedantry.

The conclusion drawn in the first chapter of this book, " that the nuclei of different kinds of cells in an individual appear to be genetically identical " is one which is generally accepted today. True, there are cases known which contradict it; the elimination of chromosomes (or chromatin) from somatic cell nuclei seen in organisms as diverse as the ciliate protozoa and various flies is well known, if not well understood. But these are exceptions and cannot be used to invalidate the general rule. Much of this Chapter considers the conclusions drawn from the amphibian nuclear transplant experiments, experiments designed to test the potential of nuclei from differentiated, or developing cells, in a most direct way. Interestingly the results of these experiments have lead to both support for and opposition to the idea that, in general, cellular differentiation is neither the result of, nor results in, stable nuclear changes. Gurdon reviews this question in detail

and makes a strong case for the argument that the progressive restrictions in nuclear potential which occur with increasing donor age result from karyotypic abnormalities arising *after* transplantation. In general terms such abnormalities would appear to be the result of the donor nucleus and host cell being out of phase so that the nucleus may be plunged into replication and division prematurely. The gross changes that may result from such an event have been dramatically illustrated in tissue culture cells fused at different stages in the cell cycle by Johnson and Rao.

Despite the elegance, and rigour, of the nuclear transplantation experiments the general conclusion expressed by Gurdon at the end of Chapter 1 does not rely on them alone. Gurdon does draw upon the results of other types of experiment, for example Wolffian regeneration of the urodele lens and the development of plants from single cells, but he has not attempted a critical review of the field as a whole. He is, for example, reluctant to enter into the vexed problem of whether or not metaplasia occurs during regeneration and has given only scant attention to the evidence that " determination " does not involve irreversible nuclear change that we see from, for example, experiments with *Drosophila*.

The conclusion that the diversity of an organism's cellular phenotypes does not reflect any corresponding diversity in nuclear genotypes raises a central problem for developmental biologists. How does this phenotypic diversity come about? In fact, it may be argued that Gurdon prejudges the answer to this question by asking, instead, " how is gene expression controlled? " It is, indeed, difficult to think about the origin of the phenotypic diversity of cells without considering the differential control of gene activity. In broad terms such control can operate at one, or more, of several different levels and Gurdon considers the major two of these: translational control and transcriptional control. There has been, in recent years, a tendency for these to be viewed as alternative methods of control and for workers in the field to polarise in favour of one at the expense of the other. Gurdon considers them in the reverse of the conventional order, translational control in Chapter 2 and transcriptional control in Chapter 3.

Much of the discussion of control at the level of RNA translation centres around the technique, developed in Gurdon's laboratory, of injecting mRNAs into frog oocytes and studying the synthesis of the proteins coded for by them. The range of such mRNAs translated by oocytes is indeed impressive, a range from mammalian haemoglobin mRNAs through an insect mRNA to the mRNA of a mammalian virus.

Gurdon concludes that there is little evidence that translational control plays a major role in the control of cellular differentiation. That is to say the extreme form of the translational control hypothesis—that all genes are transcribed all the time and that cell-type specific protein synthesis results from a control over which mRNAs are translated—is wrong. That is not to say that the rate of translation of specific messenger RNA species is not controlled, the translational block on mRNAs of unfertilised eggs is evidence enough against that view. But even here, as Gurdon points out, there is no good evidence that the different mRNA species are *differentially* affected by the block and its release after fertilisation.

" Is ", Gurdon then asks, " gene transcription controlled? " Evidence, from polytene and lampbrush chromosomes and from the pattern of RNA synthesis during amphibian development suggests strongly that it is. Gurdon

then proceeds to consider how such a control may be exercised; in particular he reviews the importance of cytoplasmic factors during early embryonic development. It is this section of the book that I find the least satisfactory. Gurdon is at pains to point out the need for the study of experimental systems in which such cytoplasmic factors can be identified and studied at the biochemical level. With Gurdon I have little doubt that such factors will exist and that they can be identified. Assuming that the final goal of such experiments is to determine, at the molecular level, just how such factors interact with the genes and, as a consequence of such interaction, control gene activity I think that it can be questioned how far the analysis can proceed without considering the gene's structure itself. Knowledge of some of the biochemical components that control individual genes may not be as great a breakthrough as might at first sight be hoped. Indeed we have, especially in hormonally induced systems such as the chick oviduct, mammalian uterus or hepatoma cells, a fair idea of what such cytoplasmic factors look like. We can even determine that they interact, either with DNA itself or with the proteins associated with the DNA, and can measure the binding constants of these interactions. But can we learn how the whole circuit is designed by knowing the structure of a few of the switches? Logically we cannot. It is the design of the circuit which is the major problem of developmental biology. It is likely that the molecular structure of the chromosome reflects the design of the circuit and it is exciting that real progress is now being made in this field. But we are very ignorant indeed of the genetic structure of the eukaryote gene. It is the lack of any consideration of the consequences our understanding the genetic structure of the eukaryote chromosomes, and of the genes themselves, will have on the way we consider how the genes are controlled that I regret in this book.

Gurdon is to be praised from not falling in with the fashion of building general " models " of genetic circuitry. Whilst fun to discuss amongst friends after dark such models are rarely of use to one who, as Brenner once said, is faced, in the bath on Sunday night, with the problem of doing an experiment on Monday morning. Such models usually suffer from the facts that they try and explain too much and that they assume so much that an extra *ad hoc* hypothesis added here and there to ' account " for some new data is rarely noticed for the degrading process that it is. Gurdon keeps very close to the experimental evidence throughout this book. There are matters here and there with which one may not agree but these are essentially ephemeral and will soon be settled one way or the other by experiment.

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HYBRIDIZATION AND THE FLORA OF THE BRITISH ISLES. Edited by C. A. Stace. Published in collaboration with the Botanical Society of the British Isles by Academic Press. London, New York and San Francisco, 1975. Pp. 626. £14·90.

For some years past there has been an increasing need for a list of the interspecific hybrids which occur in Britain and of their geographical distribution. The main reason why such a list is required lies in the fact that although a great deal of information on hybrids, both descriptive and experimental,