comparative approach fosters broader strategies used by different organisms, but occur' (p. 3). This is a very different development; as in most of the book, Drosophila and ways that make assimilation of the material for inclusion from the onslaught of information presented is of unclear importance and could have been condensed. On pages 58–69, for example, there is a lengthy discussion of the symmetric transcription of repetitive DNA sequences in S. purpuratus (and Xenopus) embryos that comes to the conclusion that no function can be ascribed to the RNAs. In this instance, the drive to be comprehensive could have been reigned in and a number of others. However, there is no escaping the basic difficulty that the field is vast and therefore the book has to be long. The absence of other books that have the same sorts of goals is probably due at least in part to a lack of authors willing to rise to the task. Other books such as Adam Wilkins' Genetic Analysis of Animal Development cover only some of the issues discussed in Davidson's book, although Wilkins' book does much more justice to the power of genetics.

Despite the large amount of material, is there anything missing that should be there? I looked for more advice and guidance from an author with such an exceptional historical perspective. History should help to guide the experimentalist. We would like to hear how to recognize which of the current approaches to developmental biology are most likely to be successful, based on lessons from the past. Wilson (1925, p. 1041) quotes R. Lankester (1877) as stating 'Though the substance of a cell [an egg] may appear homogeneous under the most powerful microscope, it is quite possible, indeed certain, that it may contain already formed and individualized, various kinds of physiological molecules.' Of the mass of available data, how are the important facts and ideas to be distinguished from the details? Are we indeed focusing too much on just a few organisms and how are we likely to err in doing so? The implicit answers to some of these questions lie within the book, but a direct assessment of where we stand and how we should best proceed would have been useful. Perhaps science is so different now that what worked for E. B. Wilson would not be as effective anymore, but I suspect that Dr Davidson would agree that Wilson would be every bit as successful in science now as he was 90 years ago. The integrated discussion of classical experimentation and modern developmental biology research is unique to Dr Davidson's and guarantees its lasting value.

Matthew P. Scott
Department of Molecular, Cellular & Developmental Biology
University of Colorado
Boulder, CO 80309-0347, USA

Teratocarcinomas and Embryonic Stem Cells: A Practical Approach
E. J. Robertson (editor)

Thirty years ago teratocarcinomas were little more than pathological oddities, of passing interest to some oncologists but quite unknown to most biologists. Their emergence from obscurity was largely due to the work of Roy Stevens and Barry Pierce who, between them, gradually impressed on their audiences the special features of these obscure tumours. At a gross level, there was something immediately fascinating in the monstrous form of some teratocarcinomas, the jumble of hair and teeth, skin and brain tissue, intestine and skeletal elements all chaotically cohabiting in a single tumour. But it was the 'life cycle' of teratocarcinomas that was especially intriguing, particularly in the context of the major advances in manipulating early mammalian embryos which occurred in the 1960s. The stem cells of teratocarcinomas (embryonal carcinoma cells, EC, cells) share many morphological, biochemical and behavioural characteristics with their natural progenitors: germ cells and early
embryonic cells. This, in itself, provided an interesting scenario for studying the differences between ostensibly malignant cells and their normal counterparts. However, it also meant that EC cells, which can be grown in large numbers and made to differentiate in culture, might serve as an invaluable, accessible source of material for analysing the characteristics of developmental changes which usually occur only in very small populations in the embryo. The supposed equivalence of EC cells and early embryonic cells was further endorsed by the demonstration that EC cells injected into a mouse blastocyst participate in subsequent development and contribute to apparently normal tissues in live chimaeras. Apart from its implications with respect to the suppression of malignancy, this experiment added a new perspective to the role of EC cells in biology. If they would also colonize the germ line of chimaeras then appropriate in vitro selection should allow the introduction of specific mutations into mouse stocks. In fact, EC cells have produced few real insights into normal embryogenesis and, as they hardly ever give rise to viable gametes in chimaeras, their potential as vehicles for gene transfer has never been realized. Nonetheless, they were a prototype and a critical spur to finding cell lines that could be used to propagate introduced genetic changes through the germ line.

Embryonic stem cells (ES cells) are cell lines derived directly from mouse blastocyst outgrowths and, while very similar to EC cells, they are far superior in their capacity to form chimaeras. Not only is their tissue distribution in chimaeras more uniform and substantial but they consistently produce extensive germ line colonization. Already it has been shown that selection in culture does not necessarily jeopardize their chances of forming functional gametes and recently two different laboratories have produced chimaeric offspring transmitting preselected mutations in the hypoxanthine phosphoribosyl transferase gene. Whatever the genetic manipulation, be it selecting specific mutations, generating new mutations by retroviral insertion, transfecting particular DNA sequences or attempting homologous recombination, ES cells offer a unique experimental system.

Transplantation of the tumours themselves and the derivation of EC cell lines from solid murine tumours is well described by Ivan Damjanov and his colleagues. There is another chapter by Andrews, Oosterhuis and Damjanov on human germ cell tumours and the isolation of cell lines from them. This gives a good brief classification of the different human tumours and a useful list of available human teratoma cell lines. In terms of making or working with these tumour cell lines, the authors are at pains to emphasize some of the difficulties.

Michael Rudnicki and Mike McBurney do an excellent job of introducing the niceties of maintaining EC lines in vitro and present the basic methods for inducing and monitoring their differentiation. On a more biochemical level, John Heath deals with the analysis of growth in cultured EC cells and their differentiated derivatives. This includes methods for developing serum-free medium, techniques for measuring cell proliferation and methods for identifying and isolating growth factors produced by EC cells.

Perhaps the chapters that will be most thumbed in the next few years are those describing the isolation and manipulation of ES cells. Liz Robertson has provided a comprehensive description of the various ways ES cells can be recovered from blastocyst outgrowths. The protocols are clear and easy to follow and there are a number of helpful photographs depicting not only correct ES cell morphology but also representatives of other cell types, not potential stem cells, which may appear during the isolation procedure. The selection of genetic variants and fusion hybrids is well covered by Martin Hooper with a useful rationale for preferred strategies and their various pitfalls. It will be an encouragement to many that the problems raised by the presence of feeder layers during selection procedures may now be a thing of the past; Buffalo rat liver cell conditioned medium, the preparation of which is described, supporting equally good growth of EC and ES cells. Methods for introducing DNA into stem cells, including calcium phosphate precipitation, electroporation, microinjection and viral infection, are reviewed by Robin Lovell-Badge. As well as giving details of the various techniques he also provides some useful protocols for extracting DNA and RNA and for doing RNA protection assays. Finally, it falls to Allan Bradley to explain how to turn the stem cells back into a mouse. He describes simple and efficient methods for making and analysing aggregation and blastocyst injection chimaeras with EC or ES cells, and his

Oncogenes and Growth Control

P. Kahn and T. Graf (editors)
Berlin: Springer-Verlag, 1986

Circumstantial evidence is accumulating, bit by bit, to convict growth factors and their signalling systems as accomplices in developmental processes. For example, growth factors from cows' brains turn out to have striking effect on the differentiation of frog embryos and certain developmental mutants in *Drosophila* turn out to be lesions in genes whose products look a lot like growth factors (dodosepicogenic) or their receptors (sevenless). This recently discovered ability to cross taxonomic barriers (often considered the hallmark of 'important' molecules) inspires confidence in the general significance of these agents which, for the last twenty years, have principally been denizens of the plastic dish and the sole preserve of mammals.

There are, in fact, sound reasons for suspecting an involvement of growth factors in morphogenesis and differentiation. A realization has emerged in recent years that growth factors are powerful pleiotropic regulators of cell phenotype and behaviour, aside from their ability to promote cell multiplication. Growth factors (along with their receptors and the baggage of signal transduction apparatus) have been found to regulate differentiation in systems as diverse as haemopoiesis, muscle, epithelia and adipocytes, and are widely expressed in developing embryos and tissues. Perhaps the most striking aspect is the selective induction of gene expression in response