each can be analysed and interpreted. Thus there is extensive discussion on measures of distance, and their various pros and cons, on measurement of and inferences from polymorphism, and on tree construction. Throughout, the underlying uniform rate molecular clock theory gives a reference point for the measures and their comparisons, and the results are related to the evolution by neutral substitution interpretation. Subsequently there is a rather brief review of population genetics theory. In these and previous chapters formulae are usually stated, perhaps with verbal argument, and the reader is referred to the original papers for derivation. Sometimes this is rather frustrating, in that the reader can not readily see what is the basis of the conclusions, but usually it is more than sufficient and the book is therefore not cluttered up with formulae. The final chapter is essentially an essay in which Nei discusses how the molecular data square with models of evolution, and in which he puts forward his own synthesis.

The book is clearly written and, as far as I detected, with few errors. (I think, however, that if Nei actually tries multiplying the matrices defined on page 355 he will find some transposition necessary.)

This is a quite different book from Kimura's *Neutral Theory of Molecular Evolution*. Nei's text deals more with methods of analysis rather than with either developing a thesis or with mathematical population genetics. Although Nei is clearly a confirmed neutralist, he uses it rather as a framework for describing and interpreting data. As such it should become a standard reference.

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Phycomyces. Edited by E. CERDA-OLMEDO and E. D. LIPSON. New York: Cold Spring Harbor Laboratory. 1987. 430 pages. $88.00. ISBN 0-87969-199-9.

This book is dedicated to the memory of Max Delbrück who was the source and inspiration behind many projects, including the exploitation of Phycomyces as a system for studying several diverse biological phenomena. The volume, consisting of 11 chapters and 8 appendices, is a fitting testimony to his influence.

The book's primary virtue is its comprehensiveness; not only are a large number of unanswered questions discussed in depth, but the literature underpinning each of them is thoroughly documented. In addition, a comprehensive, 38 page bibliography is included at the end of the book to make it an indispensible reference source of Phycomyces literature.

The most widely studied aspects of Phycomyces biology are the tropic growth responses, of which phototropism has been investigated most extensively, but the avoidance of physical barriers – fugotropism – is one of the more mysterious. A Phycomyces sporangiophore, for example, will grow away from a physical barrier placed close to its growing zone, but neither the mediator nor the receptor of this growth response has been identified. In geotropism too the receptor for the gravity stimulus is unknown. Phycomyces sporangiophores also exhibit a growth response when exposed to a laminar wind. The extent of this positive anemotropism depends on the humidity of the wind to which the sporangiophore is exposed. This observation suggests an effect of humidity on cell wall extension and this latter topic is the subject of another chapter. It is generally envisaged that fungal hyphae grow at their tips by a process of 'softening' the rigid enclosing wall, through the action of lytic enzymes, followed by the incorporation of 're-inforcing' material into the expanded cell wall. The kinetics and control of these two antagonistic reactions, either in tropic growth response or in normal cell wall extension, has still to be satisfactorily quantified, but several models of cell wall growth are extensively and critically discussed.

As one might expect, mutants which lack one or more tropic growth responses have been isolated but the contribution of genetics towards unravelling the problems in sensory physiology has been disappointing. Classical genetic analysis faces considerable problems in Phycomyces. The multinucleate nature of the cell cycle, the uncertainty over the time of nuclear fusion and meiosis, the complex tetrad analysis which follows zygospore germination, and the long dormancy period are just a few of the complicating factors which have hindered the genetic contribution.

Another surprising feature which is apparent from reviewing this book is the slight contribution which has been made up to now by genetic manipulation technology. I write 'surprising' because the possibility of a major contribution certainly exists, especially in the areas of differentiation and regeneration, and sexual morphogenesis. The book contains chapters covering the physiology and cytology of these topics, but here I was struck by the potential for breakthrough using the techniques of molecular biology. For example, experiments on regeneration from segments of sporangiophores have shown the existence of a polarity of morphogenetic information which is thought to be stored in the cell surface and cell membrane in the form of a gradient. The isolation of membrane mutants should be feasible and the molecular analysis of these together with existing mutants which are defective in sporangiophore development, should yield greater insight into differentiation and regeneration. Similarly in sexual morphogenesis the analysis of differential gene activity associated with pheromone-induced changes should allow the molecular basis of hormone action to be described.

In this review I have tried to convey some of the stimulation which I obtained from reading this book. I can recommend it as a valuable library purchase. It

will provide both a comprehensive source of information and a stimulus for researchers in fungal biology.

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Banbury Report 25: Nongenotoxic Mechanisms in Carcinogenesis. Edited by BYRON E. BUTTERWORTH and THOMAS J. SLAGA. New York: Cold Spring Harbor Laboratory. 1987. 397 pages. Cloth $70.00. ISBN 087969 225 1.

Coincident with the encroaching confusion in genetic toxicology over the role it has to play in carcinogen prediction (Tennant *et al.* (1987), *Science* **236**, 933–941), there has been a resurgence of interest in nongenotoxic factors in carcinogenesis. This interest is encouraged by this book which, wisely, does not narrow its field of view exclusively to so-called nongenotoxic carcinogens. Chemicals thought to be nongenotoxic to-day may very well be demonstrated to have genotoxic potential in the future. Nevertheless, the re-designation of a chemical as genotoxic does not necessarily mean that its carcinogenic activity is through a genotoxic mechanism. For example, trichloroethylene may be a mouse hepatocarcinogen because of its effect on peroxisomes – it is nongenotoxic in a battery of *in vitro* assays – but its metabolites (e.g. chloral) can certainly induce mutation, the absence of a significant response in the *in vitro* assays being a result of the inadequate concentrations of the mutagenic metabolites achieved in those tests. But the mere demonstration of a genotoxic metabolite from trichloroethylene does not imply that it is, after all, a genotoxic carcinogen: the dominant effect may still be peroxisomal proliferation, followed by oxidative initiation and/or promotion, or other process. Conversely, dichloromethane is strongly genotoxic, in bacterial assays, but recent work has shown that the bacterial metabolism of this compound is quite different from its mammalian metabolism and that it does not interact covalently with DNA in rats (Green *et al.* (1988), *Toxicol. Appl. Pharmacol.* **93**, 1–10).

It is not a corollary of nongenotoxic carcinogenesis that the task of anyone concerned with regulation is made easier. The theoretical expectation of a threshold effect is difficult to realise. Thus, amitrole induces rat thyroid tumours at 100 ppm in the diet, but not at 10 or 1 ppm (Steinhoff *et al.* (1983), *Toxicol. Appl. Pharmacol.* **69**, 161–169). Unfortunately, it is very rare for an experimental design to permit risk assessments to be made; experiments are almost always designed only to identify hazard. Consequently, it is difficult to conclude that 10 ppm amitrole is below the thyroid carcinogenic threshold.

The multi-step process of carcinogenesis is influenced by a large number of factors, some of which give the appearance of being at least as important as genotoxicity. This is not a new idea, but the real value of this book lies in its summary of some of these processes, review of a number of the chemical carcinogens which are nongenotoxic and – most important – stimulation of genotoxicity researchers to consider more seriously *in vivo* responses other than mutation. Dietary factors, such as deficiencies in the lipotropes choline and methionine or over-feeding, can significantly alter tumour incidence. This issue receives well-deserved attention in this book. The role of chronic hyperplasia is addressed in discussion of the hepatocarcinogenesis of many pesticides and di(2-ethylhexyl)phthalate (DEHP), the urinary tract carcinogenesis of nitrilotriacetate and a number of substances which can lead to calculus formation. Promotion and progression naturally are discussed, with particular reference to skin tumours, and foreign-body carcinogenesis occupies two chapters. *In vitro* techniques for the study of these processes, such as disruption of intercellular communication and cell transformation, do not have a current popularity, but they are not neglected here.

Because of the multiplicity of mechanisms which are likely to be involved, the study of nongenotoxic carcinogens lacks the unity of genetic toxicology and must attract researchers from a broad range of specialisations. Such a development is beneficial for the better understanding of neoplasia. This book serves as a focus for diverse activities and it is here that its importance rests. Its contents will not be entirely alien to anyone involved in carcinogenesis prediction or mechanism or carcinogen regulation, but its subject matter is a timely reminder of the complexity of these problems and the need for specialists from different backgrounds to listen to each other.

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Development Biology: A Comprehensive Synthesis Volume 4. Manipulation of Mammalian Development. Edited by R. B. L. GWATKIN. New York: Plenum Press. 1986. 388 pages. Subject index. $59.50. ISBN 0 306 42166 6.

Dr R. Gwatkin did an excellent job. He invited chapters from many good scientists who had made great contributions to the problems under discussion. As a result, we have a book which deals not only with different ways of manipulating mammalian oocytes and embryos, but also with some theoretical problems likely to be of particular importance for those interested in new ideas and new results in the field of mammalian development.

Only a few years have passed since the publication of the 5-volume series on the development of mammals edited by M. H. Johnson. The achievements made in this field since then have led to a breakthrough in our basic understanding, as well as to advances in animal breeding and in medicine. The book under review