eage view of differentiation and the quantal cell cycle concept. This is an appealing paper, but it goes far beyond what the reported data on myogenesis actually demonstrate. Weintraub's and Gurdon's papers are interesting in that they present rather different mechanistic models for genetic reprogramming, Weintraub's involving S-phase cells and Gurdon's involving chromosome condensation and decondensation accompanying mitosis.

It is once again apparent from this volume that cell differentiation and the cell cycle are intriguingly coupled, but experimental evidence so far provides no mechanistic basis for choosing between the relatively cataclysmic model of quantal mitosis and a model of more gradual reprogramming accompanying cyclic changes in the state of the genetic material. The volume brings together a wide variety of approaches to this fundamental area of developmental biology, and I strongly recommend it to investigators interested in this field, either directly or peripherally.

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Cell Biophysics

The Physiology of Giant Algal Cells. A. B. HOPE and N. A. WALKER. Cambridge University Press, New York, 1975. xiv, 202 pp. + plates. $24.95.

This small volume is mainly devoted to membrane and transport phenomena in giant algal cells. The limited scope of the book is not entirely an arbitrary choice of the authors, both physicists; a great deal of the available information is biophysical in nature. Included in the treatment are chapters on excitability, protoplasmic streaming, and photosynthetic carbon fixation, but growth and culture methods are given a quick hello and goodbye. Among the organisms, center stage is generally held by the freshwater charophyte genera, *Chara* and *Nitella*, but Raven's extensive work on *Hydrodictyon* is duly covered, and some important results on a few marine species are also included.

Hope and Walker have done a commendable job of putting into coherent form a large body of information on ionic and molecular fluxes, electrical properties of membranes, and water relations. Where the data are extensive they are organized into tables. The basic theoretical aspects of diffusive movement and electrophysiology are rigorously presented, but the treatment is not sufficiently detailed to entice the novice. In fairness to the authors it must be stated that the book is not intended as a basic textbook, but as a current guidebook for researchers and graduate students.

Difficulties begin where attempts are made to interpret material fluxes and membrane potentials in terms of simple models. These cells are far from simple: compartmentation into cell wall, cytosol, cytoplasmic organelles, and vacuole render the kinetics anything but clean. The influence of light remains a tantalizing enigma. The authors are forced into a cautious and tentative posture on almost every major issue. They have chosen, wisely I think, not to pile hypothesis on hypothesis, but to let the empirical data stand juxtaposed to the simple theoretical framework available. Helpful here are reproductions of many original figures.

Despite the inconclusiveness noted above, this is a welcome publication. It documents the considerable biophysical achievements in the field and, by its omissions, points a finger at the sadly neglected state of research on the organized biochemistry of these cells. True, large cells offer relatively little membrane material to work with, but surely a few surplus bathtubs are available for mass cultures. Biochemical studies including transport catalysis by membrane proteins should now be given top priority in research on giant algal cells. I hope that in a few years a second edition of this book will be able to record appreciable progress in this area; the field of membrane transport will be greatly enriched by such progress.

International System (SI) units are used in the book, and several attractive black-and-white photographs are included. A historical sketch of the electrophysiology of plants includes appropriate recognition of its pioneers.

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Sexual Diversities

Intersexuality in the Animal Kingdom. Papers from a symposium, Mainz, Germany, July 1974. R. REINBOTH, Ed. Springer-Verlag, New York, 1975. xvi, 452 pp., illus. $41.80.

When the primordial germ cells migrate into the germinal ridges of vertebrates or settle in the presumptive gonadal zones of invertebrates they are presumed to be undifferentiated. A hormonal milieu will then be established that ensures the differentiation of these gonia into one of two types—ova or spermatozoa. In the vertebrates and many higher invertebrates the presence of a particular chromosome or chromosome set ensures proper gonadal differentiation and therefore hormone production. The hormones act both on the nervous system to fix a neurosecretory axis in the male or female direction and on the gonia themselves to stimulate maturation of the germ cells. The gonadal secretions also act on the somatic tissues, producing the proper secondary sexual characteristics that are so important in regulating gamete transfer and care of the offspring.

The gonia appear to be intricately enmeshed in the processes described above, but their role as initiators or evocators is small. A stimulating effect on the size and form of the gonad is certainly present, but beyond this they appear merely to be products of two complex differentiation pathways. One leads to a cytoplasm-free cell, designed for rapid motility and for cell fusion and nuclear transfer, the other to a nutrient-filled cytoplasmic mass, specialized for rapid cleavage and the distribution of "factors" required for subsequent cell differentiation during embryonic development.

If these end points of differentiation are based on proper hormonal stimuli, in turn derived from the proper somatic-gonadal milieu, all derived from proper sex determination, then what are we to make of the subject of this volume? For here are 39 papers on natural and artificial intersexes (one on cnidarians, three on platyhelminthes and nemertines, six on annelids, five on arthropods, three on mollusks, one on echinoderms, nine on fishes, two on amphibians, two on reptiles, three on birds, and four on mammals). In these organisms chromosomal sex determination appears to be absent or autosomal, the hormonal milieu of one sex is not antagonistic to the germ cell differentiation of the other, and gonads are often found containing ova and spermatozoa differentiating side by side. The vertebrates (with the exception of the fishes) seem pallid in their sexual diversities by comparison with some of the invertebrates, which can be permanently bisexual and often self-fertilizing (urochordates, ctenophores, chaetognaths), be both sexes at once (annelids, mollusks, platyhelminthes, crustaceans) or alternately (crustaceans, annelids), or be half and half (arthropods). It appears that for the lower forms immutable sexual fixation is not as crucial to the functioning and survival of the species. Not only does this provide endless headaches for taxonomists and evolutionists, it also provides unusual experimental material for studies in genetics, population biology, endocrinology, behavior, and cell biology.

The utility of these systems for such studies is well brought out in this interesting volume, and almost every paper reports astonishing phenomena. The volume will among other things be a useful source of good stories for undergraduate teaching. For example, Bierne splits male and female nemertine worms longitudinally and successfully grafts heterologous halves together to create sexual chimeras. He describes maintenance of both gonadal types in the intersexes (the male half eventually predominates at least until the chimera is very old) as well as the effects of these manipulations on differentiation of accessory sex organs and surrounding somatic sexual specializations such as gland cell and pigment distribution.

Pfannenstiel describes a protandric polychaete *Ophryotrocha*, where a single individual is always male as a juvenile and then becomes permanently female. However, when a pair of females meet one of the two sheds its oocytes and its jaw apparatus and within seven days becomes a male with the proper male jaw. After spawning, the sex roles reverse, and alternation of sex and jaws between the two individuals will occur as long as the pair are kept together (the "Paarkultureffekt"). This is presumably the result of an unknown pheromone.

Using the insect *Icerya purchasi*, M. Royer describes a functional hermaphroditism derived from two separate germ lines in each individual, one haploid and one diploid. These two lines arise from the *same* polyspermic egg, the haploid line arising from accessory sperm pronuclei.

R. W. Harrington describes sex determination in hermaphroditic self-fertilizing clones of the fish *Rivulus marmoratus*, where true females are rare or nonexistent and where the production of males is temperature-controlled. Further, there can be two types of males: primary, which bear no female ducts, and secondary, which are hermaphrodites in which the female genital apparatus has been temporarily suppressed. Self-fertilizing clones of *Rivulus* have been maintained in the laboratory for over 14 years (27 uniparental generations). Reinboth and his colleagues report on experiments using the well-known Siamese fighting fish (*Betta splendens*), where removal of the sex organs of the nearly mature female results in regeneration of male gonads and sexual apparatus. The male aggressive behavior and secondary sexual characteristics also appear.

The broad range of organisms used in the research reported here is surprising. Evidently intersexuality, either permanent or transitional, is well distributed and common throughout the animal kingdom. Also evident is ignorance concerning the existence of genetic mechanisms of sex determination for most of the organisms manifesting it. It would seem useful to direct some of the considerable energies devoted here to the search for male or female sex-determining neurosecretory cells to careful karyotype analysis. Though matings can provide clues to possible chromosomal mechanisms of sex determination (as in the contribution of T. Ginsburger-Vogel), they can also produce results that would be easier to interpret if the chromosomal constitution were better known.

A concise review article by U. Mittwoch on the chromosomal mechanisms of sex determination concludes the volume. It is almost wholly confined to the vertebrates. The mechanisms of sex regulation and differentiation in invertebrates appear at this point too variable and are still too inadequately described to permit a coherent viewpoint to emerge.

Despite the diversity of sexual variations recounted in the volume one is constantly reminded of the primacy of femaleness. With few exceptions, female differentiation occurs unless it is suppressed by male-inducing substances or occurs as soon as male-inducing factors disappear. It tends to be the underlying state, as exemplified by the presence of rudimentary ovaries in permanently asexual strains of *Planaria* (Lender and Briançon). Even where the organism in question ends up a male, it often turns out to be distinctly in the minority in the population and may be a sex-reversed female trying to increase the frequency of her genes within the population by behaviorally or hormonally suppressing the reproduction of other males or females (*Science* **190**, 633 [1975]).

A curious problem arises from the specific set of differentiation restrictions placed on the primary germ cells. As nearly every paper in the volume demonstrates, oogenesis and spermiogenesis can take place simultaneously within the same gonad, often without a visible boundary between the two cell types. Some of these cases almost certainly represent transitions of sex, where the gonad bears remnants of the germ cell complement of the old sex at the same time the gonia of the new sex are maturing. However, many appear to be cases of functional hermaphroditism. A number of authors have demonstrated that germ cell differentiation is independent of sex chromosomal constitution. Rather, it appears to rely on the hormonal milieu. The simultaneous differentiation of the two germ cells in the same gonad argues against single hormonal factors, however. To account for the phenomenon one can imagine two populations of sex-determined gonia arising independently of somatic sex, an autosomal sex differentiation mechanism (responding to the external environment), a nonantagonistic hormone system like that suggested for *Lymnea* (Joosse), or a single branch point in the germ-cell differentiation program. The last possibility is particularly intriguing.

The symposium has brought together a group of workers who have published largely in European journals in French or German. The editor has seen to it that all the papers from the symposium are published in English, providing in the process a reference source for work that would have surely been largely overlooked by the English-speaking scientific community. One can object to awkward translation in some cases, and to mechanical errors in others (whole sentences repeated, for example), and even to the layout itself, which does not commend the printed page to the eye, but the overall value of the volume to so many endeavors and the thought-provoking information it contains far outweigh such matters.

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