record, but Simpson's reluctance to dwell upon them is understandable and in good taste. Students of the causation of scientific achievement may ponder his great productivity both under the stress of personal difficulties and under far more agreeable circumstances, as in his various collaborative efforts with his wife, the psychologist Anne Roe.

A final chapter defends some of the theories and principles underlying his work that have been attacked by younger students. In summary he writes, "It is as if for each of these questions . . . I had entered the ring, fought my best, delivered and received many a hard blow, and achieved a tie." Most of his contemporaries would give him a higher score.

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Plains Archeology

Prehistoric Hunters of the High Plains. GEORGE C. FRISON. Academic Press, New York, 1978. xiv, 458 pp., illus. $29.50. New World Archaeological Record.

Before the advent of the barbed wire fence and the steel plow the only way to make a living in the rigorous environment of the northwestern High Plains centering on Wyoming was by hunting and gathering. American Indian men and women cooperated in these endeavors for at least 12 millennia before the first Europeans hastily crossed the region on their way to more promising lands on the Pacific slopes. Eventually some of these newcomers adapted themselves to the region, mainly by cattle ranching, but only after the mainstay of the aboriginal economy—the bison—had been essentially exterminated by gunpowder and greed.

George Frison, the author of *Prehistoric Hunters of the High Plains*, is a member of one of the pioneer ranching families who learned to cope with the sometimes devastating, sometimes highly productive weather conditions that sweep through this land at regular intervals. Perhaps only a native of this often bitter region could fully appreciate the difficulties of surviving in it without the advantages of modern technology. Frison has gathered together in this volume a well-organized, clearly written, and beautifully illustrated set of insights into the subsistence systems of the aboriginal inhabitants. This constitutes a solid, down-to-earth attempt at an ethnography of the many human groups who successfully lived in this region from the Clovis mammoth hunters until the final heyday of the Plains buffalo.

The study paints a clear picture of human adaptation to this region by exploring how its inhabitants tackled the ever-present problem of how to obtain and process meat. Much of the time they had to resort to small mammals as well as plants gathered by the women to supplement their diet, but most of the known archeological sites are monuments to their prowess and ingenuity as hunters. Although methods for procuring antelope, sheep, deer, and elk, as well as mammoth, are discussed, most of the book concerns techniques for hunting bison, always the most abundant Plains herd animal. Especially valuable interpretations of the archeological evidence concerning butchering techniques are based upon Frison's experiments using replicated stone and bone tools made from local materials.

After an initial survey of the long cultural sequence of the Northwestern Plains, Frison interprets the field evidence he has accumulated over the last 20 years. After presenting the evidence that the Colby mammoth kill was used during winter as a deep freeze where butchered elephant cuts were stacked, he discusses the Hanson site, one of three known Folsom occupation sites on the Plains. As examples of later Paleo-Indian bison procurement methods he compares his recent reexcavation at the Agate Basin kill site with findings from the Casper site, a full account of which he has already published. The Early Plains Archaic is introduced by a discussion of the Hawken site, whose occupants still hunted giant bison (*Bison occidentalis*) with large, side-notched points in arroyo traps as late as 6400 years ago. About 4500 years ago, after a hiatus when the hunters evidently retreated to the mountains because the high Plains became too arid to support large bison herds, the Middle Archaic hunters readapted themselves to hunting bison in arroyo traps and bison pounds. Buffalo jumps with long drive lines became a major means of procurement during the Late Prehistoric Period, during which time, to judge from the abundance of sites, both the bison and their human hunters were most abundant.

Any Plains archeologist must have this book, and any professional or nonprofessional person interested in the history of man the hunter will find it fascinating reading. Any archeologist who teaches an introductory course in the field by stressing the scientific thinking processes that an archeologist should use in tackling a problem will find it invaluable as supplementary reading. As extra gems for the specialist there are appendixes by John Albanese on the archeology of the region, by Cary Madden on mammoth taxonomy, and by Frison on rock art and human osteology.

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Transport Physiology

Transport of Ions and Water in Animals. B. L. GUPTA, R. B. MORETON, J. L. OSCHMAN, and B. J. WALL, Eds. Academic Press, New York, 1977. xx, 818 pp., illus. $62.50.

Comparative Physiology. Water, Ions and Fluid Mechanics. Papers from a conference, Crans-sur-Sierre, Switzerland, Sept. 1976. K. SCHMIDT-NIELSEN, L. BOLIS, and S. H. P. MADDRELL, Eds. Cambridge University Press, New York, 1978. xii, 360 pp., illus. $42.50.

Since August Krogh wrote the first monograph on osmotic regulation in aquatic animals in 1939, the study of ion and water transport and regulation has expanded beyond the capacity of a single person. The two books under review help to overcome the resulting difficulties of communication.

The 30 essays in *Transport of Ions and Water in Animals* are dedicated to J. A. Ramsay, to commemorate his retirement from the chair of comparative physiology at the University of Cambridge. Ramsay has made fundamental contributions to the elucidation of osmoregulatory mechanisms in invertebrates, especially insects. To study the function of the excretory organs in these small animals he developed microtechniques that permitted analyses of nanoliter samples. Most appropriately, therefore, the introductory essays in the book review recent progress made in the use of microtechniques, from microperfusions of tubules of kidney and other excretory organs to electron probe x-ray analysis for the determination of ion concentrations in subcellular compartments. Several essays deal with general and theoretical aspects of transport mechanisms and transport models. The remaining 22 essays cover the subject at levels ranging from transport across cell membranes to osmoregulatory adaptations of whole organisms to their environments. All larger groups of animals are represented, but half the papers deal, exclusively or partly, with transport processes in insects,

an emphasis that presumably reflects the origin of the book. The balance among kinds of phenomena dealt with, however, reflects the trend in modern animal physiology toward the study of mechanisms at the biochemical and molecular levels or the study of adaptations of animals to their environments, especially to extreme ones.

This trend is even more clearly demonstrated in *Comparative Physiology*, which contains 23 papers presented at the International Conference on Comparative Physiology. Two of its three sections are devoted to mechanisms of transport of water and to osmotic and ionic regulation in animals living in unbalanced environments.

The third section deals with fluid mechanics in biology. The papers in this third section may have been stimulating for the participants at the conference and may have led to fruitful discussions. The discussions are, however, not included in the book, and most readers will probably find the contributions unrelated, despite their inherent interest.

Among investigators of the transport of ions and water there has been a special interest in whether water is always transported passively, secondarily to solute transport, or whether water molecules may in some cases be actively transported. Great excitement was therefore aroused when it was realized that certain insects are able to take up water from air unsaturated with water vapor. Both books attest to the interest in the mechanisms by which water molecules are taken up under such conditions. The uptake has been described in several insects, mites, and ticks, which use different mechanisms. The ability to hydrate in the atmosphere, at relative humidities varying between species from about 90 percent down to about 65 percent, thus seems to represent adaptations that have evolved independently several times in terrestrial arthropods.

The use of animals and their organs as models for more general studies of functions is as old as experimental physiology itself, and the elucidation of basic functions has often depended upon finding the animal that possesses organs or structures especially suited to the study of the functions in question. The importance of finding the right kind of animal was clearly formulated by Claude Bernard and later by Krogh. It is also a recurring theme in the books under review, most explicitly in *Transport of Ions and Water in Animals*. Both books call themselves comparative physiologies, but the use of animals and their organs as physiological models is not by itself comparative physiology. Physiology first becomes comparative at more integrated levels in the hierarchy of physiological disciplines, such as those dealing with how animals adapt functionally to their environments. In *Transport of Ions and Water in Animals* this type of physiological analysis is often referred to as ecological physiology, which may again confuse concepts. Investigations at the level of ecological physiology imply studies of the integrated function of animals as components of their ecological niche. Comparative physiology is a basic discipline within the ecological physiology of animals.

This loose use of the term "comparative physiology" is, however, widespread among physiologists, and it does not affect the value of the books as means to improve mutual understanding among specialized research workers and as source books for broader groups of biologists.

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Cell Development

Stem Cells and Tissue Homeostasis. Papers from a symposium, Manchester, England, Apr. 1977. B. I. LORD, C. S. POTTEN, and R. J. COLE, Eds. Cambridge University Press, New York, 1978. viii, 368 pp., illus. $45. British Society for Cell Biology Symposium 2.

Stem Cells and Tissue Homeostasis contains 15 papers spanning a range of studies from stem cells involved in plant development to clonal hemopathies in humans. It presents a broad overview of stem cells and cell renewal systems and brings together in one volume diverse viewpoints and varied approaches to what clearly is a central subject in cellular and developmental biology.

It is interesting that many of the contributors find it necessary to redefine "stem cell." Holtzer, for example, reconsiders the traditional concepts of "undifferentiated," "totipotent," and "multipotent" in the light of his view that at any given time a cell can have only a binary (quantal?) choice. His discussion of stem cells in relation to neoplasms and virus-transformed cells is thoughtful. Wolpert's criticisms of Holtzer's views, presented in the next paper, provide an immediate, welcome alternative. Papaioannou, Rossant, and Gardner also question the concept of the true stem cell, directing attention to the work on teratocarcinoma cells and their frequent origination from germ cell precursors. The view that germ plasm rather than germ cells may play a universal role in these tumors is worthy of more detailed experimental attention.

Nöthinger, Schupbach, Szabad, and Wieschaus present two systems in *Drosophila* representing different aspects of developmental stability and the concept of stem lines: imaginal disk development and female germ cell development. By taking advantage of the many known genetic variants and generating various genetic mosaics it is possible to obtain unique information concerning both cell lineages and cell potentials. The authors' discussion of developmental homeostasis emphasizes that there is positional regulation rather than purely clonal regulation of differentiative patterns in imaginal disks.

In his discussion of stem cells in plant growth and development, Barlow concludes that although plants do have meristematic zones (permanent meristems) the concept of the stem cell cannot by any means be applied to all aspects of meristem biology. He presents a balanced analysis of cell divisions in various regions of the meristem, of the concept of pluripotency in its application to regenerating tissues, and of the developmental changes and aging of stem cells in plant systems.

One of the most interesting papers, Clayton's review of the events leading to lens cell differentiation, is at first glance the least relevant to our notions of stem cells. In the paper, Clayton outlines the many different developmental events that must determine the direction that lens "stem cells" must take to give rise to the specific definitive cell products. At the same time precursors to those lens cells may, during regeneration or development, arise from dorsal and ventral iris, from neural retina, from pigmented epithelium, from cornea, or from the diencephalon, depending on the species studied and the conditions of the analysis employed. Clayton's paper serves as an excellent reminder of the complexity of cellular differentiation and of the regulatory mechanisms that must be operative during development.

Functional stem cell renewal systems in the intestine are discussed both by Wright, who distinguishes between "functional" and "potential" stem cells, and by Potten, who discusses the positional relations between generative and differentiative cells. Potten's view of positional controls is extended to other epithelial cell populations, and the discussion of position, asymmetry, and stem cell properties is highly original.