jor classes of vertebrates. "Vitellogenesis in insects" by J. H. Postlethwait and F. Giorgi reviews the developmental and molecular biology of yolk genes in *Drosophila*. "Vitellogenesis and oocyte growth in nonmammalian vertebrates" by R. A. Wallace summarizes work on amphibians, fish, and birds, integrating data on the ultrastructure, biochemistry, and molecular biology of these processes. "Annulate lamellae" by R. G. Kessel deals with the occurrence and morphology (54 excellent electron micrographs) of these mysterious and beautiful structures. Because we lack the ability to isolate these structures, nothing is known of their biochemistry. "Egg envelopes in vertebrates" by J. N. Dumont and A. R. Brummett is a morphological description of the extracellular matrix of eggs in the major vertebrate classes. A summary of work on the mammalian zona pellucida will help those interested in mammalian fertilization. "Oocyte maturation in amphibians" by J. L. Maller summarizes the elegant work on the involvement of cAMP-dependent protein kinase and cyclic nucleotide metabolism on the maintenance of meiotic arrest and the reinitiation of meiosis as evidenced by the breakdown of germinal vesicles. The chapter is straight biochemistry and includes discussion of the roles of protein phosphatase, calcium-calmodulin, phosphodiesterase, protein phosphorylation, maturation-promoting factor, and intracellular *p*H. "Oocyte-somatic cell interactions during oocyte growth and maturation in the mammal" by J. J. Eppig concentrates on the roles of gap junctions, cyclic AMP, and the hormonal control of cumulus cell–oocyte interaction.

The second section of the book is entitled Gene Expression: Regulation and Consequences for Oogenesis and Early Development. "RNA synthesis and storage during insect oogenesis" by S. J. Berry covers work on the cytology and biochemistry of the various classes of RNA in a variety of insect species. "Functional organization of the amphibian oocyte nucleus" by A. Scheer and M.-C. Dabauvalle is the most exciting of the chapters in the book. It summarizes what we know about lampbrush chromosomes and contains beautiful micrographs of gene transcription in action. It also describes the structure of ribonucleoprotein transcripts, amplified nucleoli, the nuclear envelope, the nucleoplasm, the storage of maternal RNA in the oocyte nucleus, and the microinjection of DNA into the nucleus. "5*S* ribosomal gene transcription during *Xenopus* oogenesis" by A. Krämer presents what is understood of the molecular biology of the control mechanisms governing the initiation and termination of transcription of these genes. "Gene expression during oogenesis and oocyte development in mammals" by R. Bachvarova reviews the cytology of oocyte development, RNA synthesis and storage in mature oocytes, chromosome structure, protein synthesis, and the role of stored macromolecules in mouse oocytes. "Informational content of the echinoderm egg" by B. P. Brandhorst covers everything known about maternal RNA in these eggs from the standpoint of molecular biology. It is an excellent concise synthesis of a large and sometimes controversial literature. "Genetic analysis of oogenesis and the role of maternal gene expression in early development" by K. D. Konrad, L. Engstrom, N. Perrimon, and A. P. Mahowald deals almost exclusively with *Drosophila* and includes a helpful section on maternal effect mutations.

This is an excellent book that will be a valuable reference source for teachers of upper-division and graduate courses in developmental biology. The illustrations are of high quality, and the subject index is extensive.

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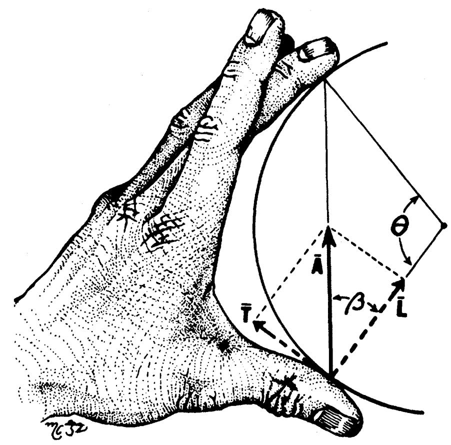
Anatomical Adaptation

Functional Vertebrate Morphology. MILTON HILDEBRAND, DENNIS M. BRAMBLE, KAREL F. LIEM, and DAVID B. WAKE, Eds. Belknap (Harvard University Press), Cambridge, Mass., 1985. x, 430 pp., illus. $35.

Intended as a second-level undergraduate textbook and general reference, this excellent book will help biologists at all levels to understand the achievements and problems of functional vertebrate morphology. The 18 chapters by 21 authors may be grouped according to a few major themes: skeletal adaptation and mechanics, locomotion, ventilation and feeding, and special senses. There is also an overview chapter by Liem and Wake.

Functional morphologists use modern analytical techniques to determine how animals work. Among the methods utilized in work described in the book are electromyography, high-speed cinematography, cinefluorography, force plates, and various transducers placed directly into skeletal or muscle tissues.

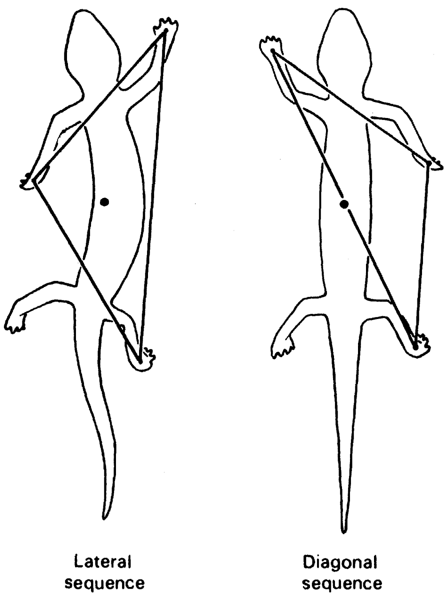


"A clawless animal grasping an object with a circular cross section exerts adduction force (*A*) along the chord of the arc (θ) that the animal subtends. Adduction force can be analyzed into a component normal to the surface (*L*) and a tangential component (*T*). Normal force equals *A* cos β, and tangential force equals *A* sin β, where β = (180° − θ)/2." [From M. Cartmill's chapter in *Functional Vertebrate Morphology*]

Additional techniques include respiratory gas analysis, and, for many approaches, computerized analysis of the often voluminous data generated.

Chapters by Lanyon and Rubin and by Alexander review the physical properties of skeletal tissues and provide a foundation for those that follow. Various authors consider different modes of locomotion by examining the biomechanical principles of bone-muscle systems. Although there is some consideration of comparative morphology, as in Norberg's discussion of the mechanics of bird, bat, and pterosaur wings, most of the analyses aim more for the construction of general models than for the study of adaptive diversity. Some attempts at synthesis are made in Bennett's chapter on energetics and locomotion and in Goslow's especially fine review of the neural control of locomotion.

A central idea in the work of several authors is that the evolution of functional mechanisms may be underlain by the conservation through time of intrinsic neuronal mechanisms. Pattern generators are hypothesized to produce motor output driving the muscular systems involved in repetitive actions such as breathing, chewing, swimming, and walking. Though constantly modulated by sensory feedback and input from supraspinal centers, they produce a highly stereotyped output that appears to evolve much more slowly than do the musculoskeletal mechanisms they control. Liem shows that the pattern of air ventilation in advanced teleosts is derived from that of prey capture with very



"Factors affecting stability for a sprawling salamander. . . . Using lateral sequence, the salamander benefits from a larger triangle of support that is better positioned under the center of mass (*dot*), as well as from undulation that increases excursion for both pairs of legs. If diagonal sequence were used, undulation could not simultaneously benefit excursion for both pairs of legs." [From M. Hildebrand's chapter in *Functional Vertebrate Morphology*]

little change in neuromuscular activity; the original pattern generators are retained. In a similar fashion, Lauder shows that suction feeding in primitive salamanders closely resembles that in fishes, despite important morphological changes. Suction feeding is ineffective in air, however, and terrestrial vertebrates have evolved a different feeding mechanism, in which head and tongue movements replace fluid movement in food transport. Bramble and Wake develop a model, incorporating stereotyped kinematic and motor events involving homologous muscle groups, that is common to a variety of tetrapods. They suggest that this is derived from a common ancestral system. Pattern generators in the brainstem may generate the stereotyped neuromuscular patterns of feeding, in a way similar to that described by Goslow for spinal cord generators in relation to locomotion. Hiiemae and Crompton show that many mammals use similar musculoskeletal mechansims to transport, process, and swallow food and speculate on the possibility of phylogenetically conservative neural control systems. If there is one idea that emerges repeatedly from the diversity of topics explored in this book, it is that the neural mechanisms controlling repetitive actions may evolve more slowly than the effector systems they drive.

The two chapters on neurosensory systems seem somewhat out of place in this book. Fay and Popper discuss the octavolateralis system and Levine the eye. Though individually excellent, these chapters do not provide a comprehensive review even of the special senses; why is there nothing on olfaction?

In the final chapter Liem and Wake conclude that functional morphology still lacks a coherent set of common principles or long-term goals. They propose that it should emphasize testable hypotheses in which the relationship between structure and function is explained in a phylogenetic framework studied through the developmental mechanisms whose modifications bring about evolutionary change. Thus cladistic analysis and evolutionary epigenetics, key elements of modern comparative biology, make a significant appearance only in the final chapter of this book. The methodological emphasis of most of the authors is on the machinery used to generate data. Liem and Wake suggest that the time has come for functional morphology to progress from the mere description of what animals do to the broader consideration of how they have come to do it.

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Cooperativity in Biochemistry

Cooperativity Theory in Biochemistry. Steady-State and Equilibrium Systems. TERRELL L. HILL. Springer-Verlag, New York, 1985. xvi, 459 pp., illus. $120.

Cooperativity Theory in Biochemistry is introduced as a book of methods for the physical biochemist or molecular biologist interested in the applications of fundamental molecular (for example, statistical mechanical) approaches to the analysis of cooperativity in equilibrium and steady-state biochemical systems. Though not intended primarily as a textbook, it follows naturally after Hill's 1960 classic *Introduction to Statistical Thermodynamics* and is suitable, with the reservations noted below, for use in graduate-level discussions of binding equilibria and kinetics.

The focus of the book is on an explicit treatment of interactive cooperativity in equilibrium and steady-state systems. By this Hill means that the cooperative interaction free energies appear explicitly, rather than being buried in composite binding constants or rate constants used in more empirical analyses of these systems. The book is logically divided into three sections, the first of which reviews the statistical-molecular treatment of noncooperative systems and summarizes some of the statistical mechanics required for a full appreciation of the subsequent material. The second and third sections cover the molecular description of cooperativity in systems with small and large numbers of interactive sites, respectively. Within each section, an attempt is made to cover equilibrium and steady-state systems in parallel in pairs of chapters. The third section concludes with rather specialized chapters on Monte Carlo studies of equilibrium and steady-state cooperative processes on two-dimensional lattices and on the extension of the mean-field (Bragg-Williams) approximation to steady-state phase transitions. As Hill notes in the preface, these final chapters are likely to be of interest principally to theoretical physicists.

Most of the strengths and limitations of the book are discussed in the preface and the chapter introductions. The book seeks to integrate the author's recent analyses of cooperativity in steady-state enzyme systems into a broader context, as well as to review the uses of the grand partition function in the equilibrium treatment of cooperative noncovalent interactions, another subject to which the author has made important contributions. Since emphasis is placed on general methods rather than on particular applications, some of the best-known examples of cooperative biochemical processes, including both systems with small numbers of sites (for example, hemoglobin and aspartate transcarbamylase) and lattice systems (for example, conformational equilibria of the α-helix and nucleic acid helices) are omitted from the book, although some references to work on these topics are provided. These omissions would make it difficult to use the book as a primary textbook or as a primary source for someone entering the field. In the examples of cooperative systems chosen to illustrate the mathematical analysis (for example, Ca^{2+} and H^{+} transport and ATP hydrolysis by the calcium ATPase of sarcoplasmic reticulum; interaction of Ca^{2+} and myosin S1 fragment with an actin-troponin-tropomyosin complex), little space is devoted to the physical description of the systems or to the physical significance of the results. Although the book is logically organized with regard to the extent and complexity of the systems analyzed and the range of the cooper-