Book Review

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Genetics and the Logic of Evolution. 1st ed. By Kenneth M. Weiss and Anne V. Buchanan. Hoboken, NJ: John Wiley & Sons, 2004. Pp. 541. $89.95.

This book aims to meld our knowledge of genes and of their biochemical and cell-biological functions with phenotypes and examines their interplay with evolution. The authors consider the impact of the recent explosion of information, which is a result of the identification of genes and pathways, on our understanding of the role of evolution.

Part I introduces the basic concepts of evolution (sequestration, diversification, modularity, duplication, variation, etc.), which are discussed more fully in subsequent chapters. It also introduces concepts such as inheritance, variation, species, branching, selection, and drift and contains a mercifully algebra-free introduction to population genetics.

Part II focuses on the mechanics of the genetic code, touching on its organization and how it is read. It includes discussion of molecular biology, DNA, RNA, gene structure, gene regulation (transcription factors and regulatory elements), and chromosomes. The organization of genetic hierarchies and pathways is also discussed, and a good explanation of neutral selection and genetic load are provided. Gene duplication, leading to the generation of gene families and their evolution, is considered. The later chapters in Part II discuss cellular organization and replication.

From there, the book begins to take a broader view. Part III examines the strategies that have evolved to deal with communication both within and between cells, necessitated by the evolution from single-cell to multicellular organisms and from fetus to adult. Evolution has tended to select duplications of a limited set of genes and domains, rather than using an ever-expanding complement of completely novel genes. Multicellularity permitted cell specialization and the development of tissues and mechanisms for their regulation and integration—for example, hormones and their receptors. An important selective force acting on organisms has been the invasion by microorganisms and, thus, the evolution of the molecular machinery required to provide an immune system good enough to maintain an organism's integrity. The immune system, in turn, requires the ability to distinguish self from nonself.

Part IV details how organisms interact with the environment (sight, taste, smell, hearing, etc.) and includes interesting information on variation and organization of olfactory receptor genes. There is also an interesting comparison of diversity in immunity versus chemodetection and of somatic versus genomic combinatorial processes. This illustrates how very different molecular solutions have evolved in response to the problem of maintaining a diverse response capability. The final two chapters in this section examine perception and the nervous system. A species' survival is critically linked to its ability to process environmental input and respond appropriately. The development of neural pathways and their organization into nervous systems have been critical evolutionary adaptations.

Part V is an overview of the unified nature of life. Billions of years of duplication events and evolutionary elaboration have resulted in a modular organization of DNA, proteins, cells, tissues, organisms, species, and ecosystems. Chapter 17 includes a discussion on how natural selection can account for the diversity seen in life on this planet. For example, evolutionary theory predicts that there will be adaptation to changes in the environment but does not predict how a species will adapt. The balance between the extent to which selection and drift have played their parts in evolution is neatly summarized: "Slow evolution with small selective coefficients at any given point in turn means stepwise nearly-neutral evolution. This in turn implies that drift can be important if not predominant at many or even most stages of the process" (p. 468).

This book is well written and would probably be mainly of interest to students of evolution who have a more philosophical perspective or to philosophy students interested in evolution. Some interesting quotes that exemplify the book's style include: "Thus, the biological traits that have been the focus of evolutionary biology (limbs, flight, and the like) are the very specific end-stages of complex developmental processes, but much of how the traits get here is genetically arbitrary. This is very different from the view of evolution that has predominated since Darwin and of molecular biology since the modern synthesis and Central Dogma" (p. 176) and "The three to four billion-year-old unbroken membrane and its contents continually ooze off buds that, when they stick more or less together we call the 'development' of an organism, when they separate we call the 'reproduction' of a new organism, and when they no longer join cells during their life history we call 'speciation'" (p. 211).

Readers may experience some frustration in using the URLs that are referenced, although this deficiency is counterbalanced by the fact that those Web sites that can be located are more likely to include current information. The book would have benefited enormously from the use of color in the figures, many of which have been reproduced from elsewhere. In some cases, to understand the figures requires going to the original source.

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