

Book Reviews

Human Growth: Assessment and Interpretation. By Alex Roche and Shumei Sun. xii + 311 pp. Cambridge: Cambridge University Press. 2003. \$85.00 (cloth).

The pace of publication of major new texts on human growth and development has increased in the past few years. New knowledge about the determinants of human growth and new ways to apply this knowledge (e.g., in demography, in economic history, in evolution theory) have revitalized the field. For decades, Cambridge University Press has been a leading publisher in the area of human growth and development. The Cambridge growth library includes major works on the history of growth research (Tanner, 1981), theoretical foundations, evolutionary and anthropological perspectives (Bogin, 1999; Ulijaszek et al., 1998), and a database of worldwide variation in growth (Eveleth and Tanner, 1976, 1990). This new book by Alex Roche and Shumei Sun (née Guo) adds a useful reference work on medical applications to the Cambridge collection.

The book is organized into five chapters designed to cover topics "... relevant to the accurate assessment and interpretation of human growth and maturation, which are central to pediatric practice and public health policies relating to children" (p. ix). The first chapter covers anthropometric equipment and its use, as well as methods for maturational assessment. The nature of growth charts and the criteria for constructing appropriate charts are also given. This chapter includes several of the more widely used growth charts in pediatric practice. Chapter 2 is a concise and clearly presented overview of mathematical techniques for modeling growth patterns. Mathematical models for the analysis of body weight, length/stature, head circumference, and body mass index (BMI) are emphasized. Models for changes in body composition, for saltations and mini-surts in growth, seasonal variation, failure-to-thrive, catch-up growth, and prediction of adult stature are also treated. The topics of growth tracking and decanalization are presented. Chapter 3 considers factors that influence growth, including genetic and family factors, hormones, substance abuse by pregnant women, breastfeeding, ethnicity, nutrition, and high altitude. Chapter 4 describes

secular changes in growth and maturity. Chapter 5 reiterates much of the material in Chapters 1 and 2, but with a bit more emphasis on "... the significance of child growth and maturity in relation to future size, function, and disease" (p. x).

This book is a reference work for advanced students and professionals in medical fields. The topics of the five chapters are presented in a descriptive and matter-of-fact fashion. Readers of the book who want a quick introduction to a topic should find this format useful. The authors usually provide four recent references (since 1990) to support any statement of fact and to give readers an entrée to the literature. Older references (from the 1950s–1970s) are provided when there are no recent publications or when the topic relates to a special interest of the authors. There is little concern with the history of study of any topic and there is scant consideration of the theoretical or biological reasons why growth and maturation should operate as they do. For this information readers will need to consult other sources, such as the books cited in this review.

The literature reviewed by Roche and Sun is confined to what the authors call the "developed countries," meaning Canada, the United States, Japan, Australia, and the nations of Europe. In a handful of instances, however, the authors cite a study from a "lesser developed" country when it illustrates a point. It is impossible to systematically review the entire world literature on growth. But, to restrict coverage to the most economically and politically dominant nations greatly reduces the usefulness of this book. The children of the wealthy nations grow and mature within a fairly narrow range of conditions for health and disease. To be sure, there are difficult conditions for growth and development for some groups, and many individuals, in the rich countries, but nothing on the scale found elsewhere in the world.

Pediatricians and public health researchers (the target audience of this book) need a broad education in the total range of variation of human growth and maturation. Such knowledge is of immediate practical importance. Migration from the poorer nations to the richer nations is the leading demographic force at work today (Bogin, 2001). Migration, including adoptions of infants, brings millions of young people into the world of medical professionals of the richer nations. Migrants carry the diseases of their

country of origin with them, and they contract the new diseases of the host country. Pediatricians and public health workers must be prepared to deal with the health, emotional, social, economic, and even political ramifications of these population movements. Given this, it is curious that the topics of migration and adoption of foreign-born children seem to be confined to one sentence, and only two references, in this book. There is no discussion of the adoption of children born within the wealthy nations, who are known to have special patterns of growth and maturation.

Chapters 1 and 2 seem to provide the best information. I have already referred one colleague, working on the mathematical analysis of longitudinal patterns of infant growth, to Chapter 2. I am especially impressed with the thoughtful and practical approach that the authors take to the construction of growth models. Readers are advised to first look at the distribution of the raw data, and then find a model that best fits the data. This is a refreshing approach, as too often a preferred model is forced on the data. The discussion of growth tracking is good, but the clinical applications of tracking published by Kowalski, Schneiderman, and colleagues, using sophisticated statistical methods, are not cited (e.g., Furey et al., 1994).

Chapter 3 provides a prodigious amount of descriptive material on factors influencing growth. There is a lot of good discussion on the role of genes, hormones, substance abuse, breastfeeding, and maturity on growth. The topic of "Ethnicity" is given three pages, which seems brief given the amount of medical and public health research activity in this area. Nutritional influences are covered well enough, except for the mineral iron. Iron deficiency anemia is the most common single-nutrient problem in the world, including the developed nations, but this is not mentioned in the book and only one 1986 reference to iron and growth is provided. The effect of industrial pollutants, such as lead, is not mentioned, which is surprising in a book that restricts its coverage to growth in the most industrialized nations. There is discussion of television viewing in relation to the epidemic of overweight (but no entry for "television" in the Index). The authors cite studies that find little or no relationship. This seems odd, as there are many well-constructed studies that show a positive relationship between body fatness and TV viewing.

Chapter 4 is devoted to secular changes in growth. The presentation is almost entirely descriptive; that is, what has happened rather than why it happened. Perhaps this is why the authors state on page 180 that it is "somewhat surprising" that increases in stature over time are often greater for the shortest groups (3rd percentile) than for the tallest groups (97th percentile). There is abundant evidence that social, economic, and political changes that lead to improvements in the environment for growth will usually benefit the least well-off in any society. The authors also state that the "... absence of secular changes in weight from birth to 2 years is unexplained" (p. 184). Birth weight and birth length are classic examples of strong stabilizing selection, so these are in fact well explained. The stability of weight until 2 years likely reflects the influence of stabilizing selection for birth weight combined with the relative insulation of the infant from external influences. More to the point would be a discussion of the causes of secular changes in the percentage of low birth weight (LBW) infants. The environmental factors responsible for secular trends, which are cited on page 183, have clear influences on LBW.

Overall, Roche and Sun's book will serve as a practical reference for its intended audience. Perhaps this new book will work best if it is used to follow up on material presented in a more basic overview of human growth and development. Some of the books already cited, as well as a recent edited text by Cameron (2002), would be the best first read for medical students, public health workers, and human biologists.

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Human Biology and History. Edited by Malcolm Smith. xiv + 219 pp. London and New York: Taylor and Francis. 2002. \$88.00 (cloth).

The stated intent of this brief volume, edited by biological anthropologist Malcolm Smith, is to “exemplify the range of common interest and to illustrate the scope and potential for interaction between the fields of human biology and history,” a body of knowledge which may be labeled “biological history” (p. 1). This volume is the outcome of a symposium held at University College, Durham (UK) under the auspices of the Society for the Study of Human Biology on this subject. The contributors to this volume represent individuals from such diverse fields as archeology, biological anthropology, biology, geography, and history who are united by their reliance on data associated with earlier (prehistoric or historic) populations. The book is organized into 10 chapters, including the brief and succinct introduction by Smith.

Chapter 2 by Landers is concerned with the nature of interaction between economic and demographic variables. After discussing the concept of adaptation from two different (Darwinian vs. Malthusian) perspectives and at two (macro vs. micro) levels, Landers applies these paradigms to English demographic data from the mid-1500s to the mid-1800s. The outcome of this analysis is that England’s demographic regime was adaptive both in the Darwinian and in the Malthusian sense at the macrolevel but not necessarily so at the microlevel.

A sociobiologically oriented Chapter 3 by Betzig relies on parish records, letters, diaries, magazines, and English literature to explore polygyny in English society. This quite long treatment considers such aspects of English life as household size and compo-

sition, fornication and adultery, whores and courtesans, kings and pimps, general debauchery, and the consequent cover-up in the form of hush money or other forms of economic favors, and includes the specifics concerning English royalty from William I to George VI. I find Betzig’s invoking of democracy and the loss of power by men as an explanation for the ending of these practices, first in England and then elsewhere, to be quite creative but somewhat less than totally convincing. After all, these practices seem to occur even in our time in ostensibly democratic societies (see, for example, Anonymous, 1996; Clinton, 2003).

Mielke, in an extremely well-focused Chapter 4, considers the impact of the 1808 War of Finland on the population structure of the Åland Islands and how that impact, in turn, was influenced by the region’s population structure and sociocultural characteristics. The relevant demographic data utilized in this analysis indicate rapid population size reduction due to high mortality in infants, children, and elderly males, along with a decrease in marriages. The elevation in mortality resulted from diseases introduced by the Swedish troops sent to protect the Ålanders and their subsequent rapid spread due to crowding and unfavorable hygienic conditions. Cox’s Proportional Hazards Survival Models are also applied to these data and indicate an interesting picture concerning survival during the course of the war as well as differences in the various islands which may be attributable to differential exposure to disease-carrying pathogens. An intriguing aspect of Mielke’s contribution are his speculations about the possible genetic implications of the observed demographic changes which could be examined in future work with the newly developed techniques of molecular genetics.

Smith’s Chapter 5 on isonymy focuses on the potential application of surname distribution measures, widely used in biological anthropology and, thus, based on genetics, to answer questions generated by historians and their kinds of debates which are genetics-free in nature. This chapter describes how historians already use surnames in their work (e.g., geographic origin and distribution; chronological and spatial distribution to infer migration patterns, local stability and transience and lineage persistence) in comparison to biological anthropologists (consanguinity and its consequences). After describing such bio-anthropological measures

as random and nonrandom F, repeated pairs, and kinship/relationship and the assumptions behind these isonymic measures, the author applies the coefficient of relationship by isonymy (R_i) to two case studies of occupational groups in order to explore their overall relationship and their temporal change. Smith suggests that these techniques, originally developed for bio-anthropological purposes, may also be meaningfully applied to historical questions and processes, including those at levels above the local community.

Chapter 6 by Oddy focuses on food consumption and the estimation of nutritional status in past populations from such historical sources as, for example, family budgets, which began to be collected in Britain in the 1780s. While the use of such sources for nutrient analysis is based on certain assumptions and contains some shortcomings, the obtained results suggest marked regional variation in food consumption with only small variation in energy values, a probable imbalance in within-family food consumption, and a long-term change in the energy composition of British diets from the 1790s to the 1930s.

Chapter 7 by Floud deals with the relatively recent approach whereby anthropometric (primarily stature) measurements recorded in historical sources are utilized in order to gain insights into economic and historical processes. Stature has increased on a worldwide basis, but there has not been a uniform secular trend in this trait and there were instances of stature decline. This latter event has generated a lively debate among economists and historians concerning the standard of living. Anthropometric measurements are subject to both genetic and complex environmental factors, and it is impossible to assign a single cause to the observed changes. Considerable challenges remain for future work to unravel the complexity of the situation.

The anthropologist, Bennike, considers paleopathology as a means to investigate the survival of six different historic populations from three separate periods in Chapter 8. Neanderthals are compared with people from the Upper Paleolithic for the earliest period, Mesolithic hunter-gatherers with Neolithic agriculturalists for the second, and Inuits with the Norse for the third. Survival is defined here broadly to include not only longevity but also various risks and traumas experienced during life. While all

indicators favor the surviving anatomically modern humans in comparison to the Neanderthals, the differences between the Mesolithic and Neolithic populations are less clear-cut in the second period (12,000–6,000 ago) under consideration. The eventual disappearance of the Norse from Greenland, the focus of the third period (1,000–500 years ago) comparison, may simply involve an out-migration strategy.

Knusel's Chapter 9 treats the relatively ignored topic of activity-related bone alteration. He briefly discusses the reasons, intellectual as well as practical, for the lack of interest in this area and calls for a consideration of nongenetic causes to explain morphological change. A few such investigations treated the relationship between strenuous activity and bone morphology in early human evolution, but Knusel suggests that such investigations could be profitably carried out to explore the major social transformations of later prehistory, protohistory, and history.

Schutkowski, in an extremely interesting human ecology-focused Chapter 10, looks at the skeletal record of a number of German settlements for heavy metal concentrations, strontium isotopes, and diet-indicating trace element levels. He explores the occupational hazards and the health conditions in 18th century smelters and their families through the accumulation of lead, cadmium, and arsenic in the skeleton. Additionally, residential mobility in Black Forest miners is analyzed by differences in strontium isotope ratios in skeletal and dental materials, whereas social class-related dietary differences are explored on the basis of such measures as stable isotope ratios of carbon and nitrogen, Sr/Ca and Ba/Ca ratios from the early medieval settlements of Weingarten and Weinigumstadt.

Personally, I found some of the contributions in this brief volume to be much more interesting than others and would have liked to see additional coverage of these particular topics. This wish would have probably slanted the focus of the work too much in favor of biological anthropology. Taken together, the various contributions to this volume do provide a brief but meaningful introduction to biological history, and individuals, regardless of disciplinary affiliation, utilizing archival data in their research or contemplating such will benefit from reading this work. Additionally, this work could also be used as a source for supplemental

readings in some of the more narrowly focused courses on biological anthropology. Finally, I view the price of this volume (\$88.00 for only 219 pages) to be a bit on the expensive side.

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The Biodemography of Human Reproduction and Fertility. Edited by Joseph Lee Rodgers and Hans-Peter Kohler. xiv + 258 pp. Boston: Kluwer Academic Publishers. 2003. \$145.00.

Biodemography is a sullied concept in anthropology. It ought to be about the biological and evolutionary basis of demographic events that determine Darwinian fitness. Usually it is merely descriptive, and I have come to expect that titles with biodemography in them will disappoint. This book is a nice surprise: it has many pieces that do just what biodemography ought to do.

The strength of the book is that it is a collection of pieces (12 chapters) from different fields in anthropology, biology, epidemiology, psychology, and even sociology that are not obviously related and tempts scholars to read outside their fields. Anthropologists, for example, learn early on that phenotypic plasticity is what humans are about, and it never occurred to me to question the assumption that phenotypic plasticity is a good thing until I read the second chapter of the book, by Hughes, Burlinson, and Rodd. Environmentally cued development may have costs not incurred by genes coding for canalized development. For example, there may be costs associated with information acquisition.

Most human reproductive ecology is based on plastic responses to the food supply or energy output, and we ought to be developing models that compare the costs of this kind of response to fixed responses. Valeggia and

Ellison in Chapter 5 use Ellison's energy balance model (see Ellison, 2001) to interpret data on the duration of lactational amenorrhea in the Toba of Northern Argentina. Unfortunately, the beauty of Ellison's energy balance model is its weakness. It explains all the data we have or ever will have on ovarian suppression. In this sense it is not a true scientific model since it is impossible to falsify.

The Toba have breastfeeding patterns similar to the !Kung Bushmen of Southern Africa. The !Kung are known for their long lactation periods and low fertility, and after Melvin Konner and Carol Worthman's landmark piece in 1980 establishing the intense lactation patterns of !Kung and suppressed ovarian activity, the 4-year-wide birth intervals of !Kung were attributed to lactational suppression. But the Toba have a surprisingly short period of lactational amenorrhea—half of all lactating Toba women have resumed cycling by 9 months postpartum, illustrating that breastfeeding intensity is not solely responsible for variation in lactational amenorrhea. Since there are no comparative data (Konner and Worthman's data were much less detailed), the piece does not elucidate the role of energetics, but Valeggia and Ellison describe some plausible physiological mechanisms for a regulatory role of food on ovarian activity.

Some variation in the timing of life history events previously attributed to plasticity can now be attributed to genetic variation. In Chapter 9 James Murray and colleagues describe differences in fertility among Honduran men with different alleles at the dopamine D2 receptor gene (DRD2)/TaqI site. DRD2/Taq1/A1+ men have earlier age at reproduction and higher fertility than DRD2/Taq1/A1- men. In the past, they argue, the higher fertility of the DRD2/Taq1 A1+ allele was balanced by higher mortality in carriers that today produces excess morbidity. They summarize a large body of literature about genes with similar effects that may be responsible for so-called diseases of modernization (e.g., hypertension).

Like all edited volumes, this book varies in quality. Because the statistical methods and the theoretical content change with each chapter, the book is unlikely to be suitable for standard undergraduate courses. Undergraduates could grasp the conclusions, but not where they came from, and there are too many statistical techniques and too

much theory and biology to introduce in a semester. Anderson and Low in Chapter 4, for example, find that the higher fertility of unmarried women disappears when covariates are included. This is an interesting but questionable finding. Many of the covariates (like age at first birth, age at marriage, and schooling) are competing risks. Women who become pregnant young are less likely to be married and receive less schooling, and a different model incorporating interactions among these terms might produce a different answer.

There are many other pieces by prominent scholars on many issues. This book should give readers a lot of new ideas with which to approach their own research problems, including up-to-date literature reviews in fields outside their own fields. It would be a great choice for a journal-club-like course in which students and faculty can hash out the issues and the consequences of better data or different statistical methods.

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Animal Social Complexity: Intelligence, Culture, and Individualized Societies. Edited by Franz B.M. de Waal and Peter L. Tyack. xvi + 616. Cambridge, MA: Harvard University Press. 2003. \$49.95 (cloth).

Two “hot” topics form the central focus of this volume: 1) the role of the social environment in the evolution of intelligence, and 2) the question of animal culture. The editors suggest that these issues are best examined in animal societies in which members recognize each other individually, build multigenerational relationships, and possess learned social and survival strategies. They introduce the volume with discussions of life history strategies in primates (van Schaik and

Deaner, Chapter 1), dolphins (Wells, Chapter 2), and elephants (Payne, Chapter 3). These and subsequent chapters on spotted hyenas (Drea and Frank, Chapter 5) and sperm whales (Mesnick et al., case study 6A) argue that brain size and intelligence correlate with life history strategies, including longevity, litter size, gestation length, precocity at birth, and slow postnatal maturation. Accordingly, social intelligence and socially transmitted behavioral traditions are predicted to differentially occur in species with long life spans and slow postnatal maturation rates.

This fine collection of works makes major contributions to our understandings of cooperation, intelligence, communication, and social learning in primates, elephants, cetaceans, sea lions, bats, and parrots. Chapters by Boesch (Chapter 4), Schusterman et al. (Chapter 7), Seyfarth and Cheney (Chapter 8), and de Waal (Chapter 9) also provide major theoretical advances in our understanding of what constitutes social intelligence and how to compare it across taxonomic groups. Seyfarth, Cheney, and de Waal’s emphases on the hierarchical nature of social intelligence, on the differential awareness of triadic relationships by different species, and on the similarities between behavioral and linguistic syntax are particularly welcome. The evidence of vocal labeling behaviors in captive chimpanzees also represents an important advance in our understanding of language-like capacities in great apes (Hallberg et al., case study 11A). Left unresolved is the key issue of whether social intelligence among some nonprimate taxa such as sea lions, spotted hyenas, and cetaceans is equivalent to that of cercopithecoid primates, as argued by Schusterman et al. (Chapter 7) and by Drea and Frank (Chapter 5), but countered on theoretical bases by Engh and Holekamp (case study 5A), Seyfarth and Cheney (Chapter 8), and de Waal (Chapter 9).

Overall, the volume’s contributions to our understandings of mammalian intelligence and to theoretical methods of analysis are so strong that it must be considered mandatory reading by all investigators in the fields of comparative mammalian intelligence and brain function. It is not clear, however, that the chapters as a group support the volume’s major assumptions. Chapters by van Schaik and Deaner (Chapter 1) and by Wilkenson (Chapter 12), for example, question the assumption that brain size and intelligence relate primarily to social complexity, noting

instead relationships between brain sizes, intelligence, and foraging strategies. Other chapters lend tacit support to these views by noting relationships between complex communication systems and feeding endeavors in captive apes (Hallberg et al., case study 11A) and wild parrots (Bradbury, Chapter 11), between tool use and foraging endeavors in capuchins (Ottoni and Mannu, case study 16A) and between complex social strategies and cooperative foraging endeavors in hyenas (Drea and Frank, Chapter 5), cetaceans (Wells, Chapter 2), and primates (Boesch, Chapter 4). Nor do the assertions by several volume contributors that great ape and/or monkey social intelligence exceeds that of long-lived, nonprimate taxa provide confidence in the existence of a straightforward relationship between life-history strategies and cognitive capacities.

We turn then to the question of culture. Most contributors assume that the social transmission of information or behavioral traits and culture are equivalent phenomena. None recognizes that many cultural anthropologists define culture in terms of symbolic systems of belief. Hence, while all contributors appear to agree that most long-lived mammals have culture on the grounds that most have socially transmitted traditions, none examines the far more challenging question of whether any mammals have symbolic systems. This trend to glorify social learning by calling it culture has become so firmly entrenched among animal behaviorists that as McGrew (Chapter 16, p. 436) states, the concept of culture has now escaped from anthropology. Anthropologists must find a word other than culture to refer to the very real human phenomena of symbolic beliefs.

However, even if we grant animal behaviorists the right to define culture in their own terms, a serious theoretical problem confronts the reader of this volume. So certain were the volume editors of a relationship between life history strategy and a capacity for socially transmitted behavioral traditions that they included very few chapters focusing on the intellectual and social learning capacities of small-bodied, short-lived species, even though social learning was first experimentally documented in rats and is now known to occur in many short-lived mammals (Box and Gibson, 1999), including two short-lived taxa that are included in the volume: bats (Wilkinson,

Chapter 12) and marmosets (Voelkl and Huber, case study 14A), as well as in many short-lived birds (West et al., Chapter 18). In short, although the volume contains many fine discussions of the social learning capacities of long-lived species, the selective nature of the material presented cannot be used to argue that such capacities are differentially present in long-lived taxa, as the editors suggest.

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What Genes Can't Do. By Lenny Moss. xxii + 228 pp. Cambridge, MA: The MIT Press (A Bradford Book). 2002. \$34.95 (cloth).

In this latest entry in the Basic Bioethics Series from the MIT press, Lenny Moss offers a provocative critique of the pervasive "gene centered" view of development that has characterized much of the scientific and popular thinking over the last 50 years. Drawing on his training as a cellular biologist and philosopher of science, the author charts the historic roots of widely held genetic misconceptions and offers a convincing alternative view that reinforces the emerging sense that both evolution and development reflect the outcome of stunningly complex interactions between molecular, cellular, and external environments. Moss contends that nucleotide sequences provide only one source of essential information and that independent domains of information are contained on the chromosome as well as in the complex architecture of the cell and its attendant receptors and organelles. The text occasionally veers into stretches of jargon-laden "deep" rhetoric characteristic of postmodern critiques of scientific gospels, but Moss is no opponent of empiricism. His goal is to present a "philosophically guided, empirically argued critique" (p. xiii). The result is a short but thoughtful, densely documented text of five chapters that

will be useful to anyone who pursues genetic research, has interest in development and evolution, or who attempts the unenviable task of introducing students to the elegant complexity of life at these basic levels.

Moss begins Chapter 1, entitled "Genesis of the Gene," with a review of the origins of the current concept of genes "as blueprints for traits" and argues that this misconception has arisen from the confluence of two long-established philosophical trends in biology. The first of these, "preformationism," assumes that the essence of developmental potential is somehow fully contained within the germ cell(s). Preformationism appears in genetic theory when "genes" are perceived as the direct source of phenotypic traits (seed shape, eye color, cystic fibrosis). Moss labels this view of the gene as "Gene-P." He notes that most biologists recognize "Gene-P" as nothing more than a convenient or utilitarian model for framing questions of heritability. Thus, there is no separate gene for blue eyes (no gene product that produces blue pigment) but rather a gene for dark pigment that for a variety of reasons is not expressed in the outer layer of the iris. The second historical influence on modern views of the gene is the theory of epigenesis, in which order (and form) is established in a progressive step-by-step fashion during the course of development. This is expressed genetically in the concepts of DNA as a codebook for life and DNA as the self-directing architect of adapted form. Moss labels this as "Gene-D" and suggests that it is consistent with standard textbook depictions of DNA as the fundamental developmental resource together with its intermediaries of RNA transcripts and their resultant proteins. The result of the intertwining of these different historical perspectives has been the creation of a gene-centered view of development (and evolution) that Moss believes misrepresents the importance of other sources of information and order. Thus, nucleotides are an important but not sufficient resource in the orchestration of development.

Chapter 2, "The Rhetoric of Life and the Life of Rhetoric," explores the historical roots of the metaphor of the genetic code. Moss takes exception with the view that this code is analogous to a language and argues that the metaphor and its supporting terms (translation, sense and nonsense, reading frame, dictionaries, and libraries) condition us to overstate the importance of

the molecular "word" (or gene) to the exclusion of the more important interactive dynamics of development (a dialogue in which, according to Moss, the context determines the meaning of the genetic "word"). Moss draws on the work of postmodern critics of the rhetoric of science (and genetics), but he is careful to avoid their strident denial of any empirical perspective. Rather, he acknowledges the obvious fact that the models and metaphors we impose on reality tend to simplify and limit our understanding of the true complexity of that reality.

The heart of this text can be found in the third chapter, "A Critique of Pure (Genetic) Information," where Moss explores the fascinating complexity of the cell and its relationship to the interpretation, integration, modification, and expression of the information provided by DNA. Moss brings together much of the revolutionary research from the past two decades that has revealed the awesome complexity of cellular architecture and its intimate relationship to the supposedly inviolable DNA "locked away" inside the nucleus. Moss maintains that the cell's membrane-based structure provides a source of information that is independent of nuclear DNA and equally critical in the synthesis of proteins (and hence the expression of traits). He notes, for example, that the signal sequence contained on the N-terminal end of a protein is the first to be synthesized in the ribosomal translational complex. However, further synthesis of the protein will cease unless and until this terminal sequence becomes associated with a specific embedded receptor protein in the endoplasmic reticulum membrane. Thus, even the first protein synthesized in a developing embryo presupposes the prior existence of such key receptors. In other words, the ovum, as the primal inherited cell, provides important "information" in the form of preexisting cellular structure that is absolutely essential to the expression of the genetic information provided by fusion of the parental gametes. He further speculates that acquired structural alterations in these cellular structures might be propagated throughout the ontological development of an individual and then potentially passed to succeeding generations. In addition to membrane dynamics, Moss discusses chromosome marking (methylation, imprinting) and steady state dynamics (emergent properties of order in complex systems) as sources of information that are parallel,

mutually dependent, and equally important to nuclear DNA in directing development. Moss refers to this view of development which is contingent on multiple resources rather than on a self-contained code script as “developmental systems theory” (p. 115).

Moss utilizes developmental systems theory to explore the etiology of cancer in Chapter 4, “Dialectics of Disorder: Normalization and Pathology as Process.” As in the previous chapters, he establishes the historical context for the prevailing ideology of “cancer genetics” and then offers an alternative that is considerably less gene-centered. Moss is convinced that an understanding of cancer, even those with well-established genetic links such as breast and colon cancer, requires a broad approach. He believes that researchers must consider the interactions of individual cells within and between cellular developmental fields. He suggests that intricate feedback exists between cells in these fields and their encompassing environment. Moss sees cell transformation as the result of an ontological process in reverse, with the cell gradually losing its specificity and identity. The process may be initiated by a somatic mutation but the probability of the multiple mutations now known to be required for most such transformations is vanishingly small unless other factors are involved. It is, Moss argues, only through a persistent disruption of the normally stabilizing cellular community around the transforming cell that metastatic cancer arises. This perception of cancer transformation as one end of a continuum of loss of cellular control (order) suggests to Moss that it might be possible to manipulate the cellular field and/or its surrounding environment to stop and even reverse the loss of cellular identity in a cancer cell.

In the final chapter, “After the Gene,” Moss considers the phylogenetic implications of a truly epigenetic view of development and gene function. The author notes that the surprisingly limited number of “structural” genes identified to date, together with the equally surprising conservation of sequence specificity across species as diverse as bacteria and humans, suggests that the orthodox primacy

given to point mutations needs to be reexamined. Moss believes that the origins of evolutionary complexity (never precisely defined) stems not from the invention of novel genes, but rather through the creation of greater flexibility in mechanisms of regulation and control in transcription initiation, gene splicing, and posttranslational modification of proteins. In this view, it is the regulation and modification of the timing and expression of gene products that has been the chief focus of selection (and allowed for the development of multicellular complexity). Further, it is through the agency of transposable elements that this modularization has occurred. Thus, what some consider “junk DNA” interposing itself between “coding sequences” or exons, Moss sees as evidence of the creation of greater situational flexibility in the utilization of the genome. Moss also offers a highly speculative but intriguing mechanism through which stress (presumably played out at a deme or population level) could unlock the potential for these transposable elements to generate increased variation (unique modules) in the germ line, hence allowing for rapid or punctuated evolution.

There is, in this final chapter, a glimpse of a deeper agenda when Moss muses on the reemergence of the living organism rather than its molecular replicators as the proper focus for the study of ontogeny and evolution. He concludes with the observation that such a change in focus may move our understanding of life from the “secular” to the “sacred” (p. 198). Regardless of how one might feel about such a loaded termination sequence, this elegantly argued and richly detailed work provides an opportunity for constructive reassessment of much of the current dogma in genetics, development, and evolution.

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