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ANNUAL REVIEW OF NUTRITION

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PREFACE

The frontiers of nutrition sciences, as represented by the contributions to Volume 7 of the *Annual Review of Nutrition*, are changing—slightly. The number of reviews in the realm of clinical nutrition has increased, and the number of reviews devoted to epidemiology and public health nutrition has decreased. The number of contributions related to the basic sciences of nutrition has decreased slightly, although the reviews have in one respect become more basic, i.e. five of them deal with modification of the genome by nutrients or metabolites. This latter development illustrates that the field of nutrition is making use of new technologies that enable investigators to probe more deeply into the nature of nutrient interaction with the most fundamental events of cell physiology, namely, gene expression.

An increase in the number of reviews dealing with clinical nutrition also reflects the application of the most modern methods for probing intermediary metabolism in human subjects. Five clinical reviews deal with nutrient effects on metabolism. More specifically one describes the assessment of energy expenditure and fuel utilization in man using whole-body calorimetry and endocrine probes, one deals with the effects of fat-modified diets on cholesterol and lipoprotein metabolism, one considers the metabolic management of obesity, one discusses the nutritional requirements of the elderly, and one recounts the nutrition requirements of low-birth-weight babies. Two reviews deal with either inherited or acquired defects of vitamin metabolism in man for vitamins B₆ and B₁₂. Two reviews add important perspectives to our understanding of minerals by discussing the causes and consequences of iron overload and giving a global survey of selenium nutrition.

Dr. Scrimshaw devoted his lead chapter to "The Phenomenon of Famine." He concluded that many of the worst famines have been caused by poor distribution of existing food supplies either because of lack of purchasing power on the part of the poor or because of political interference with normal distribution of food. Economic and social factors that prevent the consumption of food by large numbers of people, even when food supplies are adequate, are the principal causes of famine.

The reviews on basic and experimental nutrition include papers on fatty acid and amino acid transport, the formation of glycogen by a novel pathway, the fate of D-amino acids, and the regulation of intracellular protein catabolism. A review of water homeostasis and five papers on the molecular biol-

ogy of gene expression are presented. These include reviews on the role of zinc in DNA replication, the role of intracellular vitamin A-binding proteins in mediating the genetic regulatory function of vitamin A, the dietary regulation of gene expression with respect to selected enzymes of lipid and carbohydrate metabolism, the induction of salivary proline-rich proteins by tannins, and nutrient effects on DNA and chromatin structure.

Finally, in the public health and nutrition area, we have a chapter on the evolution of recommended dietary allowances (RDA) and another on nutritional applications of the Health and Nutrition Examination Surveys (HANES).

The heterogeneity of our subject is obvious from the contents of each issue of the *Annual Review of Nutrition*. This reemphasizes the fact that nutrition science is a field to which investigators from every discipline of biology make contributions. In fact, many investigators who have written for Volume 7 would not regard themselves as nutritionists. They are molecular biologists, physiologists, biochemists, pediatricians, hematologists, internists, animal scientists, epidemiologists, and statisticians. So be it! They all share, however, an interest in the science of nutrients and their relation to health.

Konrad Bloch in a recent paper¹ quotes Auguste Comte, the 19th century mathematician who ranked the sciences in order of precision. In Comte's hierarchy, mathematics stood at the top followed by physics, chemistry, and then biology, with the social sciences at the bottom of the ladder. Comte intended his hierarchy to be a value judgement of his time but, one may ask, have value judgments changed that much in the last century? Thus, continues Bloch, "In physics, classical phenomena are governed by laws, in chemistry, chemical reactions follow rules, and finally, in biology with the unpredictability of Nature, the hypotheses are more likely to be elevated to the state of dogmas, which are periodically modified, if not overturned entirely." The nutritional sciences, with their footing in both biological and social sciences, are particularly vulnerable to the overextrapolation of data to produce dogmas. Nutrition science now deals less with fully reversible single deficiencies and more with complex disorders of multiple etiology such as atherosclerosis, osteoporosis, diabetes, and cancer. These diseases have both genetic and environmental roots. Individual variation, furthermore, may totally change the relative contributions of genetic and environmental factors in the genesis of a single chronic degenerative disease.

Nutrition scientists who study the chronic diseases or models thereof, whether they work in the field of cell biology, experimental nutrition, clinical nutrition or epidemiology, should be cautious in concluding that any variable is *the cause* of any of these complex chronic diseases. Some of these variables turn out to be only one of many causes. Human variability in response to environmental factors that may affect the progression of one of these diseases

is so great that for every human who is responsive to a regimen, there is one who is resistant. Likewise, for every susceptible animal model there is one that is resistant. One must learn to respect the weight of evidence.

Dogmas are usually developed when proof is not possible, when circumstantial evidence is all that is available. This is precisely the time for all of us to moderate our hypotheses and reenter the world of physicists and chemists who play by rules, and whose phenomena are governed by laws.

Regarding nutrition science and scientists, the tilt toward dogmas must be scrupulously evaluated in developing research priorities, designing experiments, and writing reports. We must recognize that in this new, exciting, but difficult area of learning the role of nutritional factors in diseases of multiple etiology, the weaknesses as well as the strengths of evidence must be accepted. The conclusions must follow from the evidence. One of the objectives of the *Annual Review of Nutrition* is to give perspective on these issues.

I would like to thank my associates on the Editorial Committee, the consultants who aided us in assembling the reviews, and the authors of the excellent reviews appearing in Volume 7. Ms. Margot Platt, in Palo Alto, California, deserves our continuing thanks and appreciation for her important work on the production of each volume.

ROBERT E. OLSON, EDITOR

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Perrin S. Scowshan



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THE PHENOMENON OF FAMINE

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INTRODUCTION

As for all living organisms, the need for food is a fundamental determinant of human behavior. If obtaining food takes all available time and energy, there can be little social or cultural development. Nearly a quarter of the world's population, even today, is unable to obtain enough food for the level of activity they desire (79). Moreover, today, as throughout history, combinations of natural and man-made disasters result in hundreds of thousands and sometimes millions of persons passing through progressively more severe stages of undernutrition, to death. This phenomenon is referred to as famine.

Definitions of famine can be quite misleading if they emphasize inadequate production of food. The essential element is a relatively sudden collapse in the level of food *consumption* of large numbers of people. Starvation refers to peoples' going without sufficient food, and during famines people do so on such a large scale that mortality is high. As this review emphasizes, famine is not just the result of an extreme and protracted shortage of food, but also an economic and social phenomenon that can occur *when food supplies are adequate to prevent it*. Whatever the combination of causes, famine is characterized by suffering, emaciation, and death from a combination of starvation and infectious disease; it particularly decimates young children and the elderly. This article briefly describes instances of the devastating human experience of famine throughout history and briefly describes its causes. Particular attention is paid to the consequences of famine, both individual and social. Also reviewed are issues related to famine prevention and relief and the political dimensions of famine.

FAMINES IN HISTORY

Throughout recorded history famines have occurred with a high frequency in agricultural and urban populations, and the present century is no exception. While many of the areas in which famines were extraordinarily common have largely eliminated that risk, the total number of human beings exposed to the possibility of famine is still large. The available evidence suggests that famines began to occur when people developed the social organization and agricultural technology to live in large groups.

Hunters and gatherers, judged by the scanty archeological records and the examples of surviving primitive peoples such as the Australian aborigines and the African bushmen, were less subject to famine than agriculturalists. Although hunters and gatherers are subject to the same cyclical natural factors that affect food supplies, they have two adaptive mechanisms that are not as available to agriculturalists (83, 84). Hunters and gatherers can vary the area over which they seek their food supplies; they can consume a much greater variety of plants and living organisms when necessary; and they can exist in smaller groups, sometimes breaking their societies up into isolated bands that can range over a large area.

The earliest record, the Stele of Famine, found at the First Cataract of the Nile erected more than 5000 years ago, contains a classic description of famine (19, 26). At this time the Egyptian Ipuwer wrote: "Plague stalketh through the land. . . . Towns are destroyed and Upper Egypt has become an empty waste. . . . He that layeth his brother in the ground is everywhere to be seen."

Inscribed on the tomb of the Egyptian Ankhtifi circa 2000 BC was this comment: “All of Upper Egypt was dying of hunger to such a degree that everyone had come to eating his children” (30). The biblical seven years of famine during which the food stores of Joseph averted starvation for many¹ was about 1700 BC. In addition, ten famines in Palestine are referred to in nine books of the Bible covering a period from 1850 BC to 46 AD, and others occurring in Greece have been described in the writings of Plato, Thucydides, and Aristotle (30).

Famines were frequent in the Roman empire from 500 BC (30). When the empire began to deteriorate after 500 AD, transportation and communication regressed so much that famines increased in frequency and the poor died by the tens and even hundreds of thousands (30). Famine was certainly an important factor in the fall of the Roman empire (93, 107).

Between 501 and 1500, France alone experienced more than 75 famines. They were also frequently reported in England, Ireland, Scotland, Wales, Germany, Denmark, and Sweden. The famine of 1315–1317 affected all of Europe (58). According to Dando (30), a combination of plague, the Black Death, and famine killed one fourth to three fourths of the population of Western Europe in this period.

As conditions improved in Western Europe, they worsened for the peasants of Eastern Europe. Over 500,000 people are estimated to have died in one three-year famine that began in 1601 in Western Russia and the Eastern European countries bordering it (93). However, frequent famines continued in Western Europe throughout the Middle Ages, the Renaissance, and the Industrial Revolution. For example, in Italy in 1347 two thirds of the population are reported to have died (20). In 1438 one third of the population of Paris died. In London 20,000 died from 1257 to 1258 (20).

In Normandy alone famines occurred in 1727, 1737, 1739, 1752, 1764, 1765, 1767, 1768, and 1775. In 1778, 168,000 people died of famine in Bohemia and Poland (20). For the great famine in Ireland from 1845–1850, the best estimates are that some one and a half million persons died and another one million emigrated, mostly to North America (110).

In recent centuries Asia has been the principal famine area of the world. Between 108 BC and 29 AD China experienced 1829 recorded famines. This pattern continued, and the nineteenth century saw some of the most devastating famines of all (105). Four famines—in 1810, 1811, 1846, and 1849—in China claimed nearly 45 million lives, and nine million died in the famine from 1875 to 1878. As recently as 1920, an estimated 500,000 persons starved to death and twenty million were affected (59).

Murton (69) has tabulated the spacial and temporal patterns of famine in India for the 100 years from 1780 to 1880. All states experienced repeated

¹Genesis 47:13–26