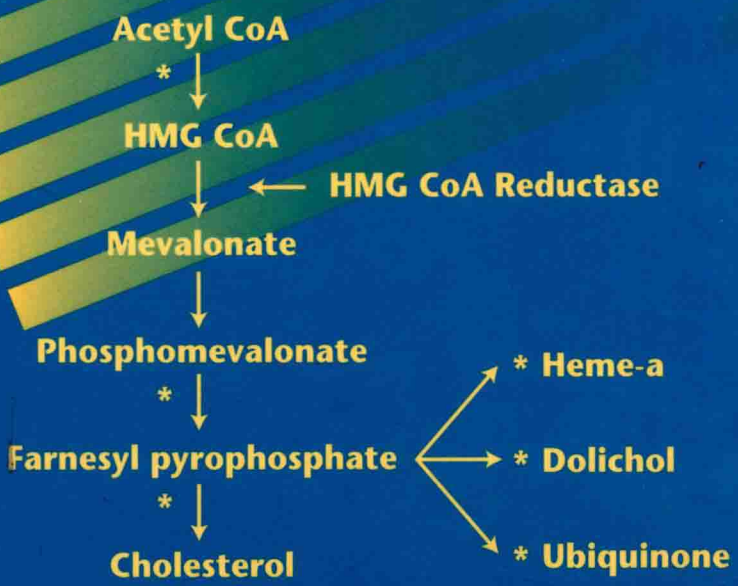
Introduction to Clinical Nutrition

Vishwanath M. Sardesai



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Preface

It is impossible to overestimate the tremendously important role that nutrition plays in the maintenance of human health, longevity, and community well-being. Dietary factors have been implicated in the etiology of at least four of the ten leading causes of death in the United States: heart disease, cancer, diabetes, and stroke. Nutrition is also crucial in many of the currently common problems such as obesity, hypertension, hypercholesterolemia, and osteoporosis. Since the advent of parenteral nutrition in clinical medicine, there has been renewed interest in nutrient requirements, especially the changes associated with bypassing the gastrointestinal tract.

Interest in nutritional information is not confined to the medical profession. Public interest in the subject is more evident today than ever before. Most individuals regard their physicians as the primary source of such information, yet in a recent extensive study of office-based primary care physicians, 68% stated that they had received inadequate nutritional training in medical school, and 86% indicated that more nutritional information should be taught as part of the basic medical curriculum.

Because doctors are admittedly not being trained to give adequate advice in this critical field, their patients have turned to unqualified, unregulated,

self-claimed experts in nutrition. This has caused a tremendous increase in food faddism and outright fraud. A report by the Surgeon General stated that nutrition fraud is the leading example of health fraud at the present time.

In 1985 the Committee of the Food and Nutrition Board of the National Academy of Sciences was commissioned to evaluate the status of nutrition training and education of the nation's physicians. Its report stated that "Nutrition education programs in U.S. medical schools are largely inadequate to meet the present and future demand of the medical profession." The Committee recommended that nutrition be a required course in every medical school in the United States and that a minimum of 25 classroom hours be devoted during preclinical years to the teaching of basic nutritional material. The National Nutrition Monitoring and Related Research Act of October 22, 1990, mandated that "Students enrolled in U.S. medical schools, as well as physicians practicing in the United States, have access to adequate training in the field of nutrition and its relationship to human health."

Many medical schools have started to increase the number of hours for nutrition education, but a common concern among medical educators is how to teach all the materials currently known in the already overcrowded, information-dense curriculum. Another problem is the lack of a suitable nutrition textbook that covers, in sufficient detail, all topics of importance to medicine, and that focuses on the interaction of nutrition and disease. For example, to understand the significance of topics such as essential fatty acids, eicosanoids, and detoxication, both pertinent biochemistry and nutritional aspects have to be in one place.

This resource is written to serve as the collective textbook for medical students during the preclinical years by addressing the multi-disciplinary requirements. It is based on a course that has proven extremely effective in teaching nutrition to medical students. Selected nutritional aspects as they relate to human health and disease and those which are generally covered during the first two years are included.

The science of nutrition deals with the processes by which components of food are made available to the body for meeting energy requirements, for building and maintaining tissues, and, in more general terms, for the maintenance of optimum functional health. Thus, nutrition is concerned with issues traditionally considered to be biochemical (e.g., digestion, absorption, transport, metabolism, biochemical nature, and the function performed by individual substances). The basic course material in this text is likely to be better received and understood after the students have been introduced to biochemistry, especially the metabolic aspects.

The book is divided into four major parts. The first chapter, "Introduction: Fundamentals of Nutrition," defines the terminology as used in the science of nutrition and briefly discusses the body's need for nutrients and

its ability to adapt within limits to conditions of nutrient deficiency or excess. Since water is covered extensively in biochemistry and physiology courses, only its role as a nutrient is included in this chapter, instead of having a separate chapter for this topic.

Part I starts with an overview of digestion and absorption of macronutrients, and is followed by a chapter that deals with the need for energy and energy-yielding substrates (carbohydrate, fat, and protein), the importance of protein in the diet (primarily to supply amino acids), and the effect of deficiency and excess of each of these macronutrients. Separate chapters cover the pertinent biochemistry and nutritional roles of essential fatty acids and the biochemistry of eicosanoids, their relation to various diseases, and strategies for dietary manipulation of eicosanoid formation. The chapter on eicosanoids (although actually not nutrients) follows essential fatty acids which serve as precursors of these biologically active compounds. Individual inorganic elements and vitamins, including vitamin-like substances, are presented in detail in terms of chemistry, food sources, biochemical role, their physiology and metabolic interrelation, and the effects of deficiency and excess of each of the micronutrients.

Part II covers the special nutritional needs during pregnancy, lactation, and the life cycle in relation to physiological changes.

Part III deals with the assessment of nutritional status, and focuses on the interaction of nutrition and some selected diseases (e.g., obesity, hyperlipidemia, osteoporosis, diabetes, and genetic diseases).

Part IV covers topics of special interest. These include dietary fiber, antioxidants, vegetarianism and other popular nutritional practices, toxicants occurring in food, additives, and how the body metabolizes many of the toxic substances present in the diet. The role of nutrients in biotransformation (detoxication mechanism) is also discussed. The chapter, "Nutraceuticals," is included because of the recent increased interest in the health effects of some foods, and their possible roles in the prevention of some chronic diseases. The health-promoting properties of many of theses foods are attributed to their content of specific non-nutrient substances, most of which act favorably on the body's detoxication mechanisms. Therefore, this topic follows the chapter entitled "Nutritional Aspects of Biotransformation."

The science of nutrition, important as it is to human welfare, has had a very long history. Centuries ago, the relationship between nutrition and medicine began with the recognition by Hippocrates that food was the source of energy and body heat. Early physicians recognized the relation between certain foods and such classical deficiency diseases as scurvy and pellagra. Today, our knowledge of the fascinating role of nutrition is growing at a geometrical rate. To help all those involved in human health to keep pace with its growth is the purpose of this book.

This text should be useful not only for students in the field of traditional medical practice, but also for those in osteopathic medicine, dentistry, and other health professions. It should be of particular interest to students who are directing their careers toward community medicine and family practice. Nutrition is a vitally important component not only of individual health, but equally vital to community well-being.

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Vishwanath M. Sardesai

Contents

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Introduction: Fundamentals of Nutrition

The science of nutrition deals with the processes by which components of food are made available to an organism for meeting energy requirements, for building and maintaining tissues, and, in a more general sense, for maintaining the organism in optimal functional health. Thus nutrition is concerned with many issues traditionally considered to be biochemical (e.g., digestion, absorption, transport, metabolism, and biochemical functions performed by individual chemical substances).

I. TERMINOLOGY

Nutrients are those chemical substances needed for growth and maintenance of normal cells, both in animals and plants. The present emphasis, however, is on human cells and tissues. *Clinical nutrition* is a medical specialty dealing with the relationship between disease and nutrition. Acute and chronic illnesses are caused by deficiencies of dietary components and others by their excesses.

Malnutrition is a condition characterized by inappropriate quality, quantity, digestion, absorption or utilization of ingested nutrients. It includes:

undernutrition—low food intake (calorie deficiency) leading to growth suppression or other deficiency signs, and *overnutrition*—to consume too much food and/or single nutrients leading to specific toxicities.

Some 45–50 chemical entities are now known to be required by humans, either preformed in food or added as an appropriate chemical substitute. These can be divided into six main categories: carbohydrates, fats, proteins, vitamins, inorganic elements, and water. Dietary fiber, although not classified as nutritionally essential, is important in maintaining good health. The term *essential* or *dietary essential* means that we must obtain the nutrient from our diet either because we lack the biochemical machinery to manufacture it or we cannot make enough of it.

Recommended Dietary Allowances (RDA) are developed by the Food and Nutrition Board of the National Academy of Sciences. They are defined as the "levels of intake of essential nutrients considered, in the judgement of Committee of Dietary Allowances of the Food and Nutrition Board, on the basis of available scientific knowledge to be adequate to meet the known nutritional needs of practically all healthy persons." Nutrient allowances are categorized into 17 classifications based on age and sex. The recommended intakes of essential nutrients must, therefore, by definition, exceed the requirements of almost all individuals in the group. The Food and Nutrition Board normally meets every six years to consider currently available information and update their recommendations. The RDAs are meant to apply only to a healthy population and should be met from the consumption of a wide variety of readily available foods. They should not be confused with nutrient requirements of individuals because these are too variable. Rather, an RDA represents an average level of daily intake of a nutrient which over time approximates the RDA, and thus the nutritional inadequacy will be rare in that population. RDAs do not provide the needs that have been altered as a result of disease states, chronic usage of certain drugs, or other factors that require specific individual attention.

The term *minimal daily requirement* (MDR) is the minimum amount of a nutrient from exogenous sources required to sustain normality (i.e., the absence of any biochemical hypofunction that is correctable by addition of greater quantities of that nutrient).

Individuals consume food more for satiation of energy needs than for individual nutrients. Therefore, to express the quality of any food in relation to its content of specific nutrient, the term *nutrient density* is used. It is defined as the concentration of a nutrient per unit of energy (e.g., 1,000 calories) in a specific food. For any nutrient the higher the nutrient density the better the food source; for example, one whole green pepper contains 20 mg of vitamin C and provides 4 calories, while one medium sweet potato

also contains 20 mg of vitamin C but provides 100 calories. Therefore, green pepper is a much better source of vitamin C than sweet potato.

A. Metabolism

All cells have in common two major general functions: energy generation and energy utilization for growth and/or maintenance. These may be termed metabolic reactions or simply *metabolism*. *Anabolism* broadly refers to processes in which relatively large molecules such as proteins are biosynthesized from small nutrient materials such as amino acids. These reactions require energy which is available in cells in the form of stored chemical energy in high energy phosphate compounds. *Catabolism* is the degradation of relatively large molecules to smaller ones. Catabolic reactions serve to capture chemical energy (in the form of adenosine triphosphate, ATP) from the degradation of energy-rich molecules. Catabolism also allows nutrients (in the diet or stored in cells) to be converted into the building blocks needed for the synthesis of complex molecules. *Intermediary metabolism* refers to all changes that occur in a food substance beginning with absorption and ending with excretion.

In the adult there is a delicate regulated balance between anabolic (synthetic) and catabolic (degradative) processes. In the growing child, input of nutrients and anabolism exceed catabolism so that the growth of tissues may occur. In the aging process or in wasting diseases, the catabolic processes exceed anabolic ones.

B. Homeostasis

The body tends to maintain a state of equilibrium within its internal environment; this is often referred to as a dynamic equilibrium or homeostasis since it occurs despite changes in the external environment. The maintenance of equilibrium is governed by an adequate supply of nutrients, a balance between nutrients, a normal complement of enzyme systems, secretion of hormones that regulate metabolic rates, and controls by the nervous system. Homeostasis plays a vital role in the body because tissues and organs can function efficiently only within a narrow range of conditions.

II. THE NEED FOR A VARIETY OF FOODS

Recommended daily allowances should be met by a variety of foods for several reasons. Most foods contain more than one nutrient but no single food item supplies all the essential nutrients in the amounts that are needed. Certain dietary components (e.g., carotenes, fiber, and possibly others) that are not