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List of Contributors

Editors-in-Chief

Lisa Hark, PhD, RD
Director, Department of Research
Wills Eye Hospital
Professor of Ophthalmology
Professor of Medicine
Jefferson Medical College
Philadelphia, PA, USA

Darwin Deen, MD, MS
Medical Professor
Department of Community Health and Social Medicine
Sophie Davis School of Biomedical Education
City College of New York
New York, NY, USA

Senior Editor

Gail Morrison, MD
Senior Vice Dean for Education
Director of Academic Programs
Professor of Medicine
Perelman School of Medicine
University of Pennsylvania
Philadelphia, PA, USA

Managing Editor

Deiana M. Johnson, MPH
Manager of Community Health
Department of Research
Wills Eye Hospital
Philadelphia, PA, USA

Associate Editor

David Weiss, BA
Doctoral Student
The Ohio State University
Department of Psychology
Columbus, OH, USA

Contributors

Sunil Adige, BS
Medical Student
Jefferson Medical College
Philadelphia, PA, USA

David J. Axelrod, MD
Assistant Professor of Medicine
Jefferson Medical College
Philadelphia, PA, USA

Diane Barsky, MD, FAAP, FACN
Assistant Professor of Pediatrics
Perelman School of Medicine
University of Pennsylvania
Attending Physician
Division of Pediatric Gastroenterology, Hepatology and Nutrition
Children's Hospital of Philadelphia
Philadelphia, PA, USA

Dara Blomain, MPH, RD, LDN
Adjunct Professor
West Chester University of Pennsylvania
West Chester, PA, USA
Adjunct Professor
Montgomery Community College
Blue Bell, PA, USA

Erik Blomain, BA
MD/PhD Student
Department of Pharmacology and Experimental Therapeutics
Jefferson Medical College
Philadelphia, PA, USA

Cecilia Borden, EdD, MSN, RN
Assistant Professor
Jefferson School of Nursing
Thomas Jefferson University
Philadelphia, PA, USA

Vicki Bovee, MS, RDN, LD
Clinical Dietitian
Western Bariatric Institute
Reno, NV, USA
Samantha Brackett, BA
Medical Student
Jefferson Medical College
Philadelphia, PA, USA

Lynne Bucovetsky, MPH, RD, LDN, CDE
Clinical Dietitian and Diabetes Educator
Department of Obstetrics and Gynecology
Thomas Jefferson University
Philadelphia, PA, USA

Frances Burke, MS, RD
Advanced Clinical Practice Dietitian
Preventive Cardiovascular Program
University of Pennsylvania Medical Center
Philadelphia, PA, USA

Jo Ann S. Carson, PhD, RD, LD
Professor and Program Director
Department of Clinical Nutrition
University of Texas Southwestern Medical Center
Dallas, TX, USA

Andrew Chapman, DO, FACP
Clinical Associate Professor of Medical Oncology
Vice Chair for Clinical Operations, Department of Medical Oncology
Director, Division of Regional Cancer Care
Co-Director, Jefferson Senior Adult Oncology Center
Kimmel Cancer Center
Thomas Jefferson University Hospital
Philadelphia, PA, USA

Bianca Collymore, MS
Medical Student
The Commonwealth Medical College
Scranton, PA, USA

Monica H. Crawford, MA, RD, LDN
Outpatient Oncology Dietitian
Department of Medical Oncology
Kimmel Cancer Center
Thomas Jefferson University Hospital
Philadelphia, PA, USA

Emil M. deGoma, MD, FACC
Assistant Professor of Medicine
Preventive Cardiovascular Medicine
Penn Heart and Vascular Center
Philadelphia, PA, USA

Horace M. DeLisser, MD
Associate Professor of Medicine
Associate Dean for Diversity and Inclusion
Perelman School of Medicine
University of Pennsylvania
Philadelphia, PA, USA

Ara DerMarderosian, PhD
Professor of Pharmacognosy
Research Professor of Medicinal Chemistry
University of the Sciences in Philadelphia
Philadelphia, PA, USA

Stephen V. Di Sabatino, BA
Medical Student
Jefferson Medical College
Philadelphia, PA, USA

Stephanie Dobak, MS, RD, LDN, CNSC
Clinical Dietitian
Jefferson Medical College
Philadelphia, PA, USA

Danielle Duffy, MD
Assistant Professor of Medicine
Division of Cardiology
Jefferson Medical College
Philadelphia, PA, USA

Andrew W. Du Pont, MD, MSPH
Associate Professor
Division of Gastroenterology, Hepatology, and Nutrition
Department of Internal Medicine
University of Texas Medical School
Houston, TX, USA

Marilyn S. Edwards, PhD, RD
Professor of Nutrition
Division of Gastroenterology, Hepatology, and Nutrition
Department of Internal Medicine
University of Texas Medical School
Houston, TX, USA

Arielle Elmaleh-Sachs, BS
Medical Student
Sophie Davis School of Biomedical Education
City College of New York
New York, NY, USA

Katherine M. Fellenstein, BS, MBA, CTP
Private Consultant
Katherine M. Fellenstein Consulting
Puyallup, WA, USA

Marion J. Franz, MS, RD, CDE
Nutrition/Health Consultant
Nutrition Concepts by Franz, Inc.
Minneapolis, MN, USA
Katherine Galluzzi, DO CMD, FACOFP
Professor and Chair
Department of Geriatrics
Philadelphia College of Osteopathic Medicine
Director, Comprehensive Care at PCOM
Medical Director, VNA Hospice of Philadelphia
Philadelphia, PA, USA

Henry Ginsberg, MD
Irving Professor of Medicine
Director, Irving Institute for Clinical and Translational Research
College of Physicians and Surgeons
Columbia University
New York, NY, USA

Laura M. Grande, MS, RD, CSP, LDN
Pediatric Dietitian
Cystic Fibrosis Center
Children's Hospital of Philadelphia
Philadelphia, PA, USA

Samuel N. Grief, MD
Associate Professor
Clinical Family Medicine
University of Illinois at Chicago
Chicago, IL, USA

Rachel Grosso, BS
Medical Student
Jefferson Medical College
Philadelphia, PA, USA

Scott M. Grundy, MD, PhD
Director, Center for Human Nutrition
Professor
University of Texas Southwestern Medical Center
Dallas, TX, USA

Indira Gurubhagavatula, MD, MPH
Associate Professor
Perlman School of Medicine
University of Pennsylvania
Philadelphia, PA, USA

Monica Habib, MS, RD, LD, CNSC
Nutrition Support Clinician
Digestive Disease Institute
Cleveland Clinic
Cleveland, OH, USA

Jo Ann T. Hattner, MPH, RD
Nutrition Consultant
Hattner Nutrition
Stanford University School of Medicine
Stanford, CA, USA

Herbert A. Hodgson, BS
Medical Student
Loma Linda University School of Medicine
San Diego, CA, USA

Elizabeth Horvitz West, MD
Ob/GYN Resident
University of California
Irvine
Department of Obstetrics and Gynecology
Irvine, CA, USA

Kathy Ireland, MS, RD, LDN
Clinical Instructor of Pediatrics
Boston University School of Medicine
Clinical Dietitian, Nutrition and Fitness for Life Program
Department of Pediatrics
Boston Medical Center
Boston, MA, USA

Gerald A. Isenberg, MD, FACS
Professor of Surgery
Director, Surgical Undergraduate Education
Chairman, Curriculum Committee
Jefferson Medical College
Program Director, Colorectal Residency
Thomas Jefferson University Hospital
Philadelphia, PA, USA

Tamara Bockow Kaplan, MD
Neurology Resident
Partners Neurology Residency Program
Massachusetts General Hospital
Brigham and Women's Hospital
Boston, MA, USA

Wahida Karmally, DrPH, RD, CDE, CLS, FNLA
Associate Research Scientist
Lecturer in Dentistry
Director of Nutrition
Irving Institute for Clinical and Translational Research
Columbia University
New York, NY, USA

Kelly Keenan, PhD
Associate Professor of Chemistry
Richard Stockton College
Galloway, NJ, USA

Erik Kelly, BA
Medical Student
Jefferson Medical College
Philadelphia, PA, USA
John A. Kerner, MD  
Professor of Pediatrics and Director of Nutrition  
Director of Pediatric Gastroenterology Fellowship  
Pediatric GI, Hepatology and Nutrition  
Stanford University Medical Center  
Medical Director  
Children’s Home Pharmacy  
Lucile Packard Children's Hospital  
Stanford University Medical Center  
Palo Alto, CA, USA

Doina Kulick, MD, MS, FACP  
Senior Associate Consultant  
Division of Preventative, Occupational and Aerospace Medicine  
Department of Medicine  
Mayo Clinic  
Arizona, USA

Calvin Lambert Jr., BA  
Medical Student  
The Warren Alpert Medical School of Brown University  
Providence, RI, USA

Ruth A. Lawrence, MD  
Distinguished Alumna Professor  
University of Rochester School of Medicine  
Rochester, NY, USA

Carine M. Lenders, MD, ScD, MS  
Associate Professor of Pediatrics  
Boston University School of Medicine  
Director, Division of Pediatric Nutrition  
Physician Scientist, Division of General Pediatrics  
Department of Pediatrics  
Boston Medical Center  
Boston, MA, USA

Susan Lupackino, MHS, RD, LDN  
Renal Dietitian  
DaVita Healthcare Partners  
Easton, PA, USA

Melissa G. Marko, PhD  
Assistant Professor  
Department of Biological Sciences  
University of the Sciences in Philadelphia  
Philadelphia, PA, USA

Maria R. Mascarenhas, MBBS  
Associate Professor of Pediatrics  
University of Pennsylvania School of Medicine  
Director, Nutrition Support Service  
Children's Hospital of Philadelphia  
Section Chief, Nutrition  
Division of Gastroenterology, Hepatology and Nutrition  
Philadelphia, PA, USA

Laura Matarese, PhD, RD, LDN, CNSC, FADA, FASPEN  
Associate Professor  
Department of Internal Medicine  
Division of Gastroenterology, Hepatology, and Nutrition  
Brody School of Medicine  
East Carolina University  
Greenville, NC, USA

Amy McKeever, PhD, RN, CRNP, WHNP-BC  
Women's Health Nurse Practitioner  
Assistant Professor in Nursing  
Villanova University  
College of Nursing  
Villanova, PA, USA

Heather McMahon, BS  
Medical Student  
Jefferson Medical College  
Philadelphia, PA, USA

Jill Murphree, MS, RD, CNSC  
Vanderbilt Center for Human Nutrition  
Vanderbilt University Medical Center  
Nashville, TN, USA

Thomas A. Novack, BS  
Medical Student  
Jefferson Medical College  
Philadelphia, PA, USA

Gerald F. O’Malley, DO, FACEP, FAAEM, FACMT, FAACP  
Associate Professor of Emergency Medicine and Toxicology  
Thomas Jefferson University Hospital  
Vice-Chair for Research and Scholarship  
Department of Emergency Medicine  
Albert Einstein Medical Center  
Philadelphia, PA, USA

Rika N. O’Malley, MD  
Clinical Instructor, Emergency Medicine Physician  
Thomas Jefferson University Hospital  
Attending Physician  
Department of Emergency Medicine  
Albert Einstein Medical Center  
Philadelphia, PA, USA

Diana Orenstein, RD, MsEd  
Clinical Dietitian  
Hartford Hospital  
Hartford, CT, USA
List of Contributors

Sharon D. Perkins, MES
Industrial Hygienist
Voluntary Protection Program
Division of Occupational Safety & Health
Washington State Department of Labor and Industries
Olympia, WA, USA

Benjamin R. Phillips, MD, FACS
Colorectal Surgeon
Thomas Jefferson University Hospital
Assistant Professor
Jefferson Medical College
Philadelphia, PA, USA

Xavier F. Pi-Sunyer, MD
Professor of Medicine, Columbia University
Director, New York Obesity/Nutrition Research Center
Columbia University College of Physicians and Surgeons
New York, NY, USA

Priyamvada M. Pitale, MBBS
Doctoral Student
Vision Science Graduate Group
University of Alabama
Birmingham, AL, USA

Alix J. Pruzansky, BA
Senior Analyst
Division of Research
The Permanente Medical Group
Oakland, CA, USA

Stephanie Rand, BS
Medical Student
Jefferson Medical College
Philadelphia, PA, USA

Barry W. Rovner, MD
Professor, Psychiatry and Neurology
Jefferson Medical College
Philadelphia, PA, USA

José Antonio S. Ruy-Díaz Renoso, MD, FICS
General Surgeon, Master in Clinical Nutrition
Vice Dean of Medicine
Faculty of Health Sciences Anahuac University
Mexico City
Staff Surgeon Hospital Angeles Lomas
Mexico City, Mexico

Douglas L. Seidner, MD
Associate Professor of Medicine
Division of Gastroenterology, Hepatology and Nutrition
Director, Vanderbilt Center for Human Nutrition
Vanderbilt University Medical Center
Nashville, TN, USA

Hirsh Sharma, BS
Medical Student
Jefferson Medical College
Philadelphia, PA, USA

Amanda J. Skwara, BS
Medical Student
Jefferson Medical College
Philadelphia, PA, USA

Pranay Soni, BS
Medical Student
Jefferson Medical College
Philadelphia, PA, USA

Andrea St. Cyr, BA
Medical Student
Jefferson Medical College
Philadelphia, PA, USA

Ezra Steiger, MD, FACS, FASPEN, AGAF
Professor of Surgery
Cleveland Clinic Lerner College of Medicine
Consultant Digestive Disease Institute
Nutrition Support and Intestinal Rehab Programs
The Cleveland Clinic Foundation
Cleveland, OH, USA

Philip Storey, MD, MPH
Ophthalmology Resident
University of Southern California
Los Angeles, CA, USA

Jean Stover, RD, CSR, LDN
Renal Dietitian
DaVita Healthcare Partners
Philadelphia, PA, USA

Catherine Sullivan, MPH, RD, LDN, IBCLC, RLC
Clinical Instructor, Director of Training
Carolina Global Breastfeeding Institute
Department of Maternal and Child Health
Gillings School of Global Public Health
University of North Carolina
Chapel Hill, NC, USA
List of Contributors

Andrew M. Tershakovec, MD, MPH
Executive Director, Clinical Research
Merck & Co., Inc.
North Wales, PA, USA

Brian W. Tobin, PhD
Professor and Chair
Department of Biomedical Sciences
University of South Carolina School of Medicine
Greenville
Greenville Health System University Medical Center
Greenville, SC, USA

Charles P. B. Vanderpool, MD
Assistant Professor of Clinical Pediatrics
Division of Pediatric Gastroenterology, Hepatology, and Nutrition
Indiana University School of Medicine
Riley Hospital for Children at Indiana University Health
Indianapolis, IN, USA

Julie Vanderpool, RD, MPH, RN, MSN, ACNP
GI Nurse Practitioner
Nashville Gastrointestinal Specialists
Nashville, TN, USA

Prachi Vishwasrao, MD
Resident, Internal Medicine
SUNY Stony Brook University Hospital
Stony Brook, NY, USA

Judith Wylie-Rosett, EdD, RD
Atran Foundation Chair in Social Medicine
Professor and Division Head for Health Promotion and Nutritional Research
Department of Epidemiology and Population Health
Albert Einstein College of Medicine
Bronx, NY, USA

Andrew Zheng, BA
Medical Student
Jefferson Medical College
Philadelphia, PA, USA

Reviewers

Victoria M. Adeleke, MPH, RD, LDN
Nutrition Supervisor
Wake County Health Clinic
Raleigh, NC, USA

Brenda W. Beatty, MPH, RD
Health Educator/Nutritionist
Alice Aycock Poe Center for Health Education
Raleigh, NC, USA

Judi Cheskin, MS, RD
Registered Dietician
Plymouth Meeting, PA, USA

Sonia Steele, MPH, RD, LDN
University Liaison
Community Health Coalition, Inc.
Durham, NC, USA
Preface

The development of *Medical Nutrition & Disease* began in 1990 as a self-instructional, case-based textbook for medical students and was first published by Wiley-Blackwell in 1995. The 5th edition now includes 13 chapters and 26 cases, all of which continue to be co-written by a multidisciplinary team of registered dietitians and physicians. Medical students and medical residents have also been invited to contribute to several 5th edition chapters and cases, offering an opportunity to educate these trainees about nutrition and target our audience. This new edition also recognizes the increasingly important role of team-based care and interprofessional education. During the development of the 5th edition, the Interprofessional Education Collaborative (IPEC) was formed which aims to promote and encourage interprofessional learning experiences to better prepare future clinicians for team-based care of patients. The national organizations included in the IPEC are the Association of American Medical Colleges, American Association of Colleges of Nursing, American Association of Colleges of Osteopathic Medicine, American Association of Colleges of Pharmacy, American Dental Education Association, and the Association of Schools of Public Health. These groups represent higher education in allopathic and osteopathic medicine, dentistry, nursing, pharmacy, and public health and have created core competencies for interprofessional collaborative practice that can guide curricula development at all health professions schools. *Medical Nutrition & Disease* is designed so that medical, physician assistant, dietetic, nursing, public health, and pharmacy students and practitioners can enhance their nutrition knowledge, skills, and attitudes to provide effective counseling to patients with or at risk for a variety of chronic conditions – essentially the ideal text for interprofessional learning.

Over the past 20 years, the role of a healthy lifestyle in preventing and treating the most common chronic diseases, such as obesity, cancer, heart disease, hypertension, and diabetes continues to mount. Each chapter and case is based on strong scientific evidence supporting nutrition and physical activity interventions and provides practical advice on how to counsel patients to make positive behavior and lifestyle changes. All cases include “before and after” diets and over 50 references are included at the end of each chapter. The 5th edition also includes six new cases, covering emerging nutrition issues for macular degeneration, menopause, celiac disease, polycystic ovarian syndrome, colon cancer, and lead poisoning in children.

Registered dietitians and dietetic technicians can earn 48 pre-approved continuing education credits from the Academy of Nutrition and Dietetics by successfully completing the multiple choice questions included in the book. There are no additional fees and all forms and directions are inserted inside the back cover.

Lisa Hark, PhD, RD
Darwin Deen, MD, MS
Gail Morrison, MD

For more information on how to successfully incorporate nutrition into your curriculum or clinical practice, contact:

Lisa Hark, PhD, RD
Director, Department of Research
Wills Eye Hospital
840 Walnut Street, Suite 1530
Philadelphia, PA. 19107-5109
610-659-1834
hark@LisaHark.com
www.LisaHark.com
Part I
Fundamentals of Nutrition Assessment
Overview of Nutrition Assessment in Clinical Care

Lisa Hark¹, Darwin Deen², and Alix J. Pruzansky³

¹ Jefferson Medical College, Philadelphia, PA
² City College of New York, New York, NY
³ The Permanente Medical Group, Oakland, CA

OBJECTIVES

- Recognize the value of nutrition assessment in the comprehensive care of ambulatory and hospitalized patients.
- Obtain an appropriate patient history, including medical, family, social, nutrition/dietary, physical activity, and weight histories; use of prescription and over-the-counter medicines, dietary and herbal supplements; and consumption of alcohol and other recreational drugs.
- Demonstrate how to interpret physical findings that reflect nutritional status, including body mass index, waist circumference, growth and development, and signs of nutritional deficiency.
- Describe the diagnosis, prevalence, health consequences, and etiology of obesity and malnutrition.
- Identify the most common physical findings associated with vitamin/mineral deficiencies or excesses.
- List the laboratory measurements commonly used to assess the nutritional status of patients.

Source: Objectives for chapter and cases adapted from the NIH Nutrition Curriculum Guide for Training Physicians. (www.nhlbi.nih.gov/funding/training/naa)

Nutrition Assessment in Clinical Care

Nutrition assessment is the evaluation of an individual’s nutritional status based on the interpretation of clinical information. Nutrition assessment is important because obesity and malnutrition are common in the clinical setting. The purpose of nutrition assessment is to:

- accurately evaluate an individual’s dietary intake and nutritional status,
- determine if medical nutrition therapy and/or counseling is needed,
- monitor changes in nutritional status, and
- evaluate the effectiveness of nutritional interventions.

Accurate nutritional assessment leads to correct diagnosis and treatment. Many patients can benefit from medical nutrition therapy (MNT) using established evidence-based protocols.

Integrating Nutrition into the Medical History and Physical Examination

The following illustrates how nutrition can be integrated into all components of the clinical assessment, including the medical history, diet history, review of systems, physical examination, laboratory data, and treatment plan.
Medical History

Past Medical History
Standard past medical history including immunizations, hospitalizations, surgeries, major injuries, chronic illnesses, and significant acute illnesses may have nutritional implications. Detailed information should be obtained about current or recent medication use including vitamins, minerals, laxatives, topical medications, over-the-counter medications, and products such as nutritional or herbal supplements which patients frequently fail to report as medications. Nutritional supplements include any products that may alter caloric, vitamin, or protein intake. Whether the patient has any known food allergies (i.e., peanut, gluten) or suffers from lactose (milk) intolerance is also important.

Family History
In assessing risk for future diseases, patients are asked to identify their parents, siblings, children, and partner, give their respective ages and health status, and indicate familial occurrences of disease or cause of death of any deceased family members. Family history of diabetes, cancer, heart disease, thyroid disease, obesity, hypertension, osteoporosis, food allergies, eating disorders, or alcoholism should be ascertained. Food sensitivity may be based on inherited immune system characteristics and family history of food intolerance should be assessed.

Social History
The diet history is typically obtained as part of the patients’ social history because socioeconomic factors such as who the patient lives with and what resources they have available influence food selection and preparation. Pertinent non-medical information recorded in the social history includes the patient’s occupation, daily exercise pattern, and marital and family status. Information should be solicited regarding the patient’s education, economic status, residence, emotional response and adjustment to illness, and any other information that might influence the patient’s understanding of his or her illness and adherence to a nutritional therapy. Details concerning the duration and frequency of the patient’s use of substances such as alcohol, tobacco, illicit drugs, and caffeine are also documented. These data can be extremely useful when formulating the treatment plan. Economic limitations that influence access to an adequate diet, difficulties shopping for or preparing food, participation in feeding programs (e.g. Women, Infants, and Children (WIC), Meals on Wheels) are relevant aspects of the nutritional assessment.

The Importance of Taking a Diet History
The purpose of obtaining dietary information from patients is to assess their nutritional intake and establish a baseline from which to negotiate changes. Infants, children, adolescents, pregnant women, older adults, and patients with a family history of or who have diabetes, hypertension, heart disease, hyperlipidemia, obesity, eating disorders, alcoholism, osteoporosis, gastrointestinal or renal disease, cancer, or weight loss or gain should consistently be asked about their eating habits, even during routine visits. Relative strengths for each method of collecting dietary information are described in this section. In addition, patients’ past and/or current dietary patterns, such as vegetarian or kosher diet practices, cultural background, and social situations should be considered during the interview. Family members who purchase and prepare foods should be invited for the interview process whenever possible. Diet-related questions may take a few minutes, if properly directed (See Table 1-1). Registered dietitians typically collect more detailed information from a diet history and make this information available to the physician, nurse practitioner, or physician assistant. This history may include information on food preferences, portion sizes, frequency of eating out, and emotional responses to eating. The detailed intake information can be used to determine calories, fat, protein, sodium, and fiber intake along with adequacy of vitamin and mineral intake can serve as a basis for counseling.
Chapter 1 Overview of Nutrition Assessment in Clinical Care

24-Hour Recall

Purpose This informal, qualitative, questioning method elicits all foods and beverages the patient has consumed in the preceding 24 hours. This method is recommended for follow-up visits for patients with diabetes because of the ability to assess the timing of meals, snacks, and insulin injections.

Questions “Starting with the last thing you ate please describe everything that you ate or drank within the past 24 hours (meals and snacks), including quantities, and how you prepared these foods.” Family members are usually consulted if the patient is a child or unable to convey adequate detail. Patients can be asked to write down what they ate the day before while they are waiting to be seen. Hospitalized patients can be monitored through calorie counts reported by the nursing or dietary staff, who can record the daily amounts of food and drink the patient consumes. Keep in mind that the 24-hour recall method, when used alone, may underestimate or overestimate a person’s usual caloric intake because the patient’s recollection may not reflect long-term dietary habits. It may be helpful to add the question, “Is this fairly typical or was there something unusual about yesterday?” Use caution generalizing this information.

Usual Intake/Diet History

Purpose Similar to the 24-hour recall, a usual intake/diet history is a retrospective method to obtain dietary information by asking the patient to recall his or her normal daily intake pattern, including amounts of foods consumed. This method is suggested for older adults who may
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frequently skip meals, or for interviewing pediatric patients whose diets may not be varied. This approach provides more information about usual intake patterns than others and tends to reflect long-term dietary habits with greater accuracy.

**Questions** “Please tell me what you usually eat and drink during the day for meals and snacks?” As a busy clinician, this question may be all that you will have time to ask, but it can serve as a screening mechanism to identify patients who need further screening with a registered dietitian. When using this approach it is important to be flexible. Begin by asking patients to describe their usual intake and if they cannot recall their usual diet, ask what they ate and drank the day before (a switch to the 24-hour recall method). You can then ask if these 24 hours are typical. Also bear in mind that some patients tend to report having eaten only those foods that they know are healthy. It is also important to ask patients if they have changed their diet for health reasons or because of a health professional’s advice.

**Food Frequency Questionnaire**

**Purpose** The food frequency questionnaire is another retrospective approach used to determine trends in a patient’s usual consumption of specific foods.

**Questions** Patients are usually asked several key questions regarding the frequency of intake of particular foods. Frequencies have been created to identify daily, weekly, or monthly consumption patterns and are especially good for specific nutrients (e.g., fiber, iron, or saturated fat). Patients can be asked these questions during the history, or these items can be added to the written form for new patients that can be mailed to them prior to their visit or completed while they are in the waiting room. For the clinician, questions can be geared toward the patient’s existing medical conditions, which is why this method is effective for patients with diabetes, heart disease, hypertension, or osteoporosis and can be used for evaluating current intake of, for example, fruits, vegetables, dairy products, or processed foods.

**Three-Day Food Record**

**Purpose** Unlike the retrospective tools mentioned earlier, a food record is ideally completed prospectively and daily as patients consume their usual diet and reviewed by the clinician at the medical visit. More accurate results can be obtained by collecting data over a longer period (e.g., 7 days).

**Questions** Patients are asked to record information on meals, food items, quantity consumed, preparation methods, etc., and details such as activities while eating, mood, hunger level, etc., can also collected. This method is preferred for active patients who may be trying to adhere to a new dietary regimen (e.g., a weight loss diet). Three-day records are the most accurate reflection of patients’ diets but it is difficult for most patients to keep a written log, including portion sizes, of everything they ate and drank over three days.

**Review of Systems**

This subjective reexamination of the patient’s history is organized by body systems. It differs from the past medical history by concentrating on symptoms, not diagnoses, and by emphasizing current more than past information. All positive and negative findings are listed. Nutrition questions vary according to the patient’s age. One goal of this part of the history is to determine whether any dietary changes have occurred in the patient’s life, either voluntarily or as a consequence of illness, medication use, or psychological problems. Examples within the review of systems that may have nutritional implications (and their potential significance) include weakness and fatigue (anemia), clothes tighter or looser (weight gain or weight loss), post-meal cramping or diarrhea (lactose
intolerance), chronic headaches, fatigue, gastrointestinal symptoms (gluten sensitivity), constipation (low fluid or fiber intake), amenorrhea (anorexia nervosa), or changes in appetite.

**Physical Examination**
The physical examination begins with the patient’s vital signs (blood pressure, heart rate, respiration rate, temperature), height, weight, body mass index (BMI), and general appearance. For example, “On examination, she is a well-developed, athletic woman.” When terms such as obese, overweight, undernourished, thin, well-nourished, well-developed, or cachectic (profound, marked state of ill health and malnutrition) are used, they should be supported by findings in the physical examination and noted in the problem list.

**Body Mass Index (BMI)**
To calculate BMI using the metric system:

\[
\text{BMI} = \frac{\text{weight (kg)}}{\text{height (m)}^2}
\]

To calculate BMI using English units:

\[
\text{BMI} = \frac{\text{weight (lbs)}}{\text{height (in)}^2 \times 703}
\]

Body mass index provides a more accurate measure of total body fat (adiposity) than body weight alone. The BMI is also more accurate than the older height–weight tables, which were based on a homogeneous population, primarily Caucasian, with higher than average socioeconomic status. BMI has also been shown to more estimate obesity than bioelectrical impedance tests. BMI values associated with the lowest mortality increase slightly as people age. However, BMI may overestimate body fat in very muscular people and underestimate body fat in some underweight people who have lost lean tissue, such as the elderly. Classifications of underweight, normal weight, overweight, and obesity are shown in Table 1-2. Health professionals should routinely assess height, weight, and BMI, and evaluate growth and development in infants, children, and adolescents.

**Diagnosis and Assessment of Overweight and Obesity**

**Body Mass Index (BMI)**
According to the National Heart Lung and Blood Institute’s (NHLBI) *Clinical Guidelines*, many people with a BMI of 25 kg/m\(^2\) or greater begin to experience negative health effects, such as elevated low-density lipoprotein cholesterol (LDL-C) and total cholesterol levels, high blood pressure, and glucose intolerance. These guidelines define overweight individuals as those with a BMI of 25

<table>
<thead>
<tr>
<th>Classification</th>
<th>BMI Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt;18.5 kg/m(^2)</td>
</tr>
<tr>
<td>Normal weight</td>
<td>18.5–24.9 kg/m(^2)</td>
</tr>
<tr>
<td>Overweight</td>
<td>25–29.9 kg/m(^2)</td>
</tr>
<tr>
<td>Obesity (Class 1)</td>
<td>30–34.9 kg/m(^2)</td>
</tr>
<tr>
<td>Obesity (Class 2)</td>
<td>35–39.9 kg/m(^2)</td>
</tr>
<tr>
<td>Extreme obesity (Class 3)</td>
<td>≥40 kg/m(^2)</td>
</tr>
</tbody>
</table>

*Table 1-2*  Classifications of BMI

to 29.9 kg/m² and obese individuals as those with a BMI of 30 kg/m² and above. The NHLBI Clinical Guidelines classify BMI as shown in Table 1-2. BMI values can be determined from height and weight measurements as shown in Figure 1-1.

**Waist Circumference**

Waist circumference is an independent measure of risk in normal weight and overweight individuals. Excess fat located in the abdominal area (termed visceral adipose tissue) is reflected by waist circumference measurement. Waist circumference is a predictor of morbidity, and is considered an independent risk factor for diabetes, dyslipidemia, hypertension, and cardiovascular disease when BMI is not markedly increased. In patients with a BMI greater than 35 kg/m², there is little additional risk from elevated waist circumference, as severe risk is already present. Therefore, measuring waist circumference is recommended in patients with a BMI less than 35 kg/m². The waist circumference measurement is particularly important for patients with a family history of diabetes and those who may be borderline overweight.

In order to obtain an accurate waist circumference measurement, patients should be standing in only their underwear. A horizontal mark should be drawn just above the uppermost lateral border of the right iliac crest, which should then be crossed with a vertical mark in the midaxillary line. The measuring tape is placed in a horizontal plane around the abdomen at the level of this mark on the right side of the trunk. The plane of the tape should be parallel to the floor and the tape should be snug but not tight. Patients should be advised to breathe normally while the measurement is taken. Waist circumference values greater than 102 cm (40 inches) in men and greater than 88 cm (35 inches) in women are considered indicators of increased risk, although these values may differ for different ethnic groups. Waist circumference is one of the diagnostic criteria of metabolic syndrome (Chapter 1: Case 1). In patients trying to lose weight by exercising, waist circumference may decrease without significant weight loss.

**Percent Weight Change**

Weight loss is very common in hospitalized patients and those residing in chronic care facilities. Weight loss is also frequently seen in older adults or those with decreased changes due to chronic illnesses such as cancer, gastrointestinal problems, or secondary to surgery, chemotherapy, or radiation therapy. If weight loss is identified in the medical history or review of systems, it is essential to take a diet and weight history and determine the percent weight change over that period of time using the patient's current body weight and usual weight. Severity of weight loss is defined by percent change in a defined period of time (Table 1-3).

\[
\text{Percent weight change} = \frac{\text{Usual Weight} - \text{Current Weight}}{\text{Usual Weight}} \times 100
\]

**Physical Examination Findings**

Nutrition-oriented aspects of the physical examination focus on the skin, hair, eyes, mouth, nails, extremities, abdomen, skeletal muscle, and fat stores. Areas to examine closely for muscle wasting include the temporalis muscles, thenar, hypothenar, and interosseous muscles on the hands. The skeletal muscles of the extremities are a less sensitive indicator of malnutrition. Subcutaneous fat stores should be examined for losses due to a sudden decrease in weight or for excess accumulation in obesity. Isolated vitamin deficiencies such as scurvy or pellagra are rarely seen in modern clinical practice. At the present time, the most commonly encountered nutritional problem seen in clinical practices in the United States and many developed countries is obesity and its associated complications. Specific clinical signs that are attributable to nutrient deficiences and significance on physical examination are shown in Table 1-4. Combined nutrient deficiencies are still seen in those with disordered intake such as alcoholics or patients receiving chemotherapy.
### Body Mass Index Chart

<table>
<thead>
<tr>
<th>in/cm</th>
<th>5'0&quot; 150/45</th>
<th>5'1&quot; 155/46</th>
<th>5'2&quot; 160/50</th>
<th>5'3&quot; 165/54</th>
<th>5'4&quot; 170/55</th>
<th>5'5&quot; 175/56</th>
<th>5'6&quot; 180/59</th>
<th>5'7&quot; 185/61</th>
<th>5'8&quot; 190/64</th>
<th>5'9&quot; 195/66</th>
<th>5'10&quot; 200/68</th>
<th>5'11&quot; 205/70</th>
<th>6'0&quot; 210/73</th>
<th>6'1&quot; 215/75</th>
<th>6'2&quot; 220/77</th>
<th>6'3&quot; 225/79</th>
<th>6'4&quot; 230/82</th>
</tr>
</thead>
<tbody>
<tr>
<td>------</td>
<td>-------------</td>
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<td>-------------</td>
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<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>&lt;18.5</td>
<td>19–24.9</td>
<td>25–29.9</td>
<td>&gt;30</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
### Table 1-3 Interpretation of Percent Weight Change

<table>
<thead>
<tr>
<th>Time</th>
<th>Significant Weight Loss</th>
<th>Severe Weight Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 week</td>
<td>1–2%</td>
<td>&gt;2%</td>
</tr>
<tr>
<td>1 month</td>
<td>5%</td>
<td>&gt;5%</td>
</tr>
<tr>
<td>3 months</td>
<td>7.5%</td>
<td>&gt;7.5%</td>
</tr>
<tr>
<td>6 months</td>
<td>10%</td>
<td>&gt;10%</td>
</tr>
<tr>
<td>1 year</td>
<td>20%</td>
<td>&gt;20%</td>
</tr>
</tbody>
</table>

### Table 1-4 Physical Examination Findings with Nutritional Implications

<table>
<thead>
<tr>
<th>Exam</th>
<th>Nutritional implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vital signs</td>
<td>Blood pressure, height, weight, BMI, percent weight change</td>
</tr>
<tr>
<td>General</td>
<td>Wasted, cachectic, overweight, obese, muscle weakness, anorexic, waist circumference</td>
</tr>
<tr>
<td>Skin</td>
<td>Acanthosis nigricans (obesity, metabolic syndrome, insulin resistance, diabetes)</td>
</tr>
<tr>
<td></td>
<td>Ecchymosis (vitamin K, C deficiency)</td>
</tr>
<tr>
<td></td>
<td>Dermatitis (marasmus, niacin, riboflavin, zinc, biotin, EFA deficiency)</td>
</tr>
<tr>
<td></td>
<td>Follicular hyperkeratosis (vitamin A deficiency)</td>
</tr>
<tr>
<td></td>
<td>Petechiae (vitamin A, C, K deficiency)</td>
</tr>
<tr>
<td></td>
<td>Pigmentation changes (niacin deficiency, marasmus)</td>
</tr>
<tr>
<td></td>
<td>Pressure ulcers/delayed wound healing (kwashiorkor, diabetes, vitamin C, zinc deficiency)</td>
</tr>
<tr>
<td></td>
<td>Psoriasiform rash, eczematous scaling (zinc deficiency)</td>
</tr>
<tr>
<td></td>
<td>Purpura (vitamin C, K deficiency)</td>
</tr>
<tr>
<td></td>
<td>Scrotal dermatosis (riboflavin deficiency)</td>
</tr>
<tr>
<td></td>
<td>Pallor (iron, folic acid, vitamin B₁₂, copper, vitamin e deficiency)</td>
</tr>
<tr>
<td></td>
<td>Thickening and dryness of skin (linoleic acid deficiency)</td>
</tr>
<tr>
<td>Hair</td>
<td>Dyspigmentation, easy pluckability (protein), alopecia (zinc, biotin deficiency)</td>
</tr>
<tr>
<td>Head</td>
<td>Temporal muscle wasting (marasmus and cachexia)</td>
</tr>
<tr>
<td></td>
<td>Delayed closure of fontanelle (pediatric undernutrition or growth retardation)</td>
</tr>
<tr>
<td>Eyes</td>
<td>Night blindness, xerosis, bitot spots, keratomalacia (vitamin A deficiency)</td>
</tr>
<tr>
<td></td>
<td>Photophobia, blurring, conjunctival inflammation, corneal vascularization (riboflavin deficiency), macular degeneration</td>
</tr>
<tr>
<td>Mouth</td>
<td>Angular stomatitis (riboflavin, iron deficiency)</td>
</tr>
<tr>
<td></td>
<td>Bleeding gums (vitamin C, K, riboflavin deficiency)</td>
</tr>
<tr>
<td></td>
<td>Cheilosis (riboflavin, niacin, vitamin B₆ deficiency)</td>
</tr>
<tr>
<td></td>
<td>Dental caries (fluoride deficiency)</td>
</tr>
<tr>
<td></td>
<td>Hypogeusia (zinc, vitamin A deficiency)</td>
</tr>
<tr>
<td></td>
<td>Glossitis (riboflavin, niacin, folic acid, vitamin B₁₂, vitamin B₆ deficiency)</td>
</tr>
<tr>
<td></td>
<td>Nasolabial seborrhea (vitamin B₆ deficiency)</td>
</tr>
<tr>
<td></td>
<td>Papillary atrophy or smooth tongue (riboflavin, niacin, iron deficiency)</td>
</tr>
<tr>
<td></td>
<td>Fissuring, scarlet or raw tongue (niacin, folate, B₁₂, B₆ deficiency)</td>
</tr>
<tr>
<td>Neck</td>
<td>Goiter (iodine deficiency)</td>
</tr>
<tr>
<td></td>
<td>Parotid enlargement (marasmus, bulimia)</td>
</tr>
<tr>
<td>Thorax</td>
<td>Thoracic achitic rosary (vitamin D deficiency)</td>
</tr>
<tr>
<td>Abdomen</td>
<td>Abdominal obesity (metabolic syndrome, diabetes, heart disease)</td>
</tr>
<tr>
<td></td>
<td>Diarrhea (niacin, folate, vitamin B₁₂ deficiency, marasmus)</td>
</tr>
<tr>
<td></td>
<td>Hepatomegaly/ascites (kwashiorkor, alcoholism)</td>
</tr>
<tr>
<td>Cardiac</td>
<td>Heart failure (thiamin, selenium deficiency, anemia)</td>
</tr>
<tr>
<td>Genital/urinary</td>
<td>Delayed puberty (marasmus, eating disorder, celiac disease)</td>
</tr>
<tr>
<td></td>
<td>Hypogonadism (zinc deficiency)</td>
</tr>
<tr>
<td>Extremities</td>
<td>Ataxia (vitamin B₁₂ deficiency, vitamin B₆ toxicity)</td>
</tr>
<tr>
<td></td>
<td>Bone ache, joint pain (vitamin C deficiency)</td>
</tr>
<tr>
<td></td>
<td>Bone tenderness, kyphosis (vitamin D deficiency)</td>
</tr>
</tbody>
</table>
Chapter 1  Overview of Nutrition Assessment in Clinical Care

<table>
<thead>
<tr>
<th>Exam</th>
<th>Nutritional implications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Edema (thiamin or protein deficiency)</td>
</tr>
<tr>
<td></td>
<td>Growth retardation, failure to thrive (energy deficiency)</td>
</tr>
<tr>
<td></td>
<td>Hyporeflexia (thiamin deficiency)</td>
</tr>
<tr>
<td></td>
<td>Bone tenderness, kyphosis (calcium, vitamin D deficiency)</td>
</tr>
<tr>
<td></td>
<td>Muscle wasting and weakness (vitamin D, magnesium deficiency, marasmus)</td>
</tr>
<tr>
<td></td>
<td>Tenderness at end of long bones (vitamin D deficiency)</td>
</tr>
<tr>
<td></td>
<td>Squaring of shoulders—loss of deltoid muscles (kwashiorkor)</td>
</tr>
<tr>
<td>Nails</td>
<td>Spooning (koilonychias) (iron deficiency)</td>
</tr>
<tr>
<td></td>
<td>Transverse lines (kwashiorkor, hypochacemia)</td>
</tr>
<tr>
<td>Neurological</td>
<td>Dementia, delirium, disorientation (niacin, thiamin, vitamin E deficiency)</td>
</tr>
<tr>
<td></td>
<td>Loss of reflexes, wrist drop, foot drop (thiamin deficiency)</td>
</tr>
<tr>
<td></td>
<td>Ophthalmoplegia (vitamin E, thiamin deficiency)</td>
</tr>
<tr>
<td></td>
<td>Peripheral neuropathy (thiamin, vitamin E, vitamin B₁₂ deficiency)</td>
</tr>
<tr>
<td></td>
<td>Tetany (vitamin D, calcium, magnesium deficiency)</td>
</tr>
</tbody>
</table>

Source: Lisa A. Hark, PhD, RD and Darwin Deen, MD, MS. 2014. Used with permission.

**Laboratory Data Used to Diagnose Nutritional and Medical Problems**

No single blood test or group of tests accurately measures nutritional status. Therefore clinical judgment is important in deciding what tests to order based on the individual’s history and physical findings. The following tests are grouped according to medical condition.

**Alcoholism:** Aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma-glutamyl transferase (GGT), thiamin, folate, and vitamin B₁₂.

**Anemia:** Complete blood count (CBC), serum iron and ferritin, total iron binding capacity (TIBC), transferrin saturation, mean corpuscular volume (MCV), reticulocyte count, red blood cell folate, and serum vitamin B₁₂.

**Diabetes:** Fasting serum glucose, hemoglobin A1C, insulin levels, C-reactive protein (CRP), serum, and urinary ketone bodies.

**Eating Disorders:** Potassium, albumin, serum amylase, thyroid studies, beta carotene aspartate amino transferase (AST), alanine aminotransferase (ALT), and anemia.

**Fluid, Electrolyte, and Renal Function:** Sodium, potassium, chloride, calcium, phosphorus, magnesium, blood urea nitrogen (BUN), creatinine, urine urea nitrogen, urinary and serum, oxalic acid, and uric acid.

**Hyperlipidemia:** Cholesterol, triglyceride, low density lipoprotein-cholesterol (LDL-C), high density lipoprotein-cholesterol (HDL-C), LPa, homocysteine, and thyroid stimulating hormone (TSH) (secondary cause).

**Musculoskeletal pain, weakness:** 25(OH) vitamin D, phosphate, parathyroid hormone (PTH).

**Malabsorption:** 24-hour fecal fat, barium imaging studies, electrolytes, albumin, serum triglycerides, and hydrogen breath test.

**Metabolic Syndrome:** Fasting serum glucose, lipid panel, and uric acid.

**Refeeding Syndrome:** Albumin, calcium, phosphorous, magnesium, and potassium.

**Malnutrition: Protein Status**

Clinically, visceral protein status may be depleted by increased protein losses in the stool and urine as a result of wounds involving severe blood loss, or by poor dietary protein intake. The following serum protein levels may prove useful in conjunction with other nutrition assessment parameters.
Once again, however, each of these tests has limitations because serum protein levels are affected not only by nutrition and hydration status, but by disease states, surgery, and liver dysfunction. The half-life ($t_{1/2}$) of each protein is given because it allows use of these tests to monitor changes in protein nutrition over time:

- **Serum albumin** Serum albumin has a half-life of 18 to 20 days and reflects nutritional status over the previous 1 to 2 months. Levels may decrease with acute stress, overhydration, trauma, surgery, liver disease, and renal disease. False increases occur with dehydration. This test is not a good indicator of recent dietary status or acute changes in nutritional status (less than 3 weeks) given its long half-life. Significantly reduced levels of serum albumin (<3.5 mg/dL) have been associated with increased morbidity and mortality in clinical studies.

- **Serum transferrin** Serum transferrin has a half-life of 8 to 9 days. Changes in serum transferrin levels are influenced by iron status, as well as by protein and calorie malnutrition. Results of this test reflect intake over the preceding several weeks.

- **Serum prealbumin** With a half-life of 2 to 3 days, serum prealbumin reflects nutritional status as well as protein and calorie intake over the previous week. Prealbumin levels may be falsely elevated with renal disease or, as with albumin, reduced with severe liver disease.

**Assessment and Problem List: Medical Nutrition Therapy**

The healthcare professional clinically assesses the individual patient based on his/her history, review of systems, physical examination, and laboratory data. Active problems are listed in order of their importance. Inactive problems are also recorded. Evidence of a nutrition disorder should be considered primary if it occurs in patients with no other etiology that explains signs and symptoms of malnutrition. A primary nutrition problem is usually the result of imbalances, inadequacies, or excesses in the patient’s nutrient intake. Manifestations may include obesity, weight loss, malnutrition, or poor intake of vitamins or minerals such as iron, calcium, folate, vitamin D, or vitamin $B_{12}$.

Patients having normal weight and no other risk factors should be encouraged to maintain their weight. Overweight patients with co-morbidities, such as diabetes, hypertension, or heart disease, should be advised to lose weight by increasing their physical activity level and reducing their total calorie and saturated fat intake, using smaller portion sizes, and selecting healthier foods. Referral to a registered dietitian for additional counseling and support has been shown to be effective.

Secondary nutrition problems occur when a primary pathologic process results in inadequate food intake, impaired absorption and utilization of nutrients, increased loss or excretion of nutrients, or increased nutrient requirements. Common causes of secondary nutritional disorders include anorexia nervosa, malabsorption, trauma, acute medical illness, and surgery. Malnutrition may occur as a result of a chronic condition or an acute episode complicating an underlying disease. After assessing each problem, medical nutrition therapy should be recommended that includes both a diagnostic component and a treatment plan. Patient education is an essential part of medical nutrition therapy. Key dietary issues by age and disease are summarized in Table 1-5.

**Estimating Energy and Protein Requirements**

**Resting Energy Expenditure (REE)**

The amount of energy required to maintain vital organ function in a resting state over 24 hours is referred to as the resting energy expenditure (REE). Basal metabolic rate (BMR) is the minimum calorie requirement for an individual at a neutral environmental temperature while fasting. BMR is generally impractical to measure. REE is approximately 10 percent above BMR. Thus, the REE is used clinically for estimation of BMR. REE accounts for approximately 65 percent of total daily energy expenditure and varies considerably among individuals with different height, weight, age,
body composition, and gender. REE significantly correlates with lean body mass. Regular physical activity, especially weight-bearing exercises, can increase muscle mass, and thus increase REE. Since REE decreases as people age due to the loss of lean body mass over time, regular exercise can play a significant role in maintaining REE, especially in older adults. The energy produced by the oxidation of dietary macronutrients is shown in Table 1-6. The Mifflin–St. Jeor equation to estimate energy requirement is shown in Table 1-7. Activity factors are added to the REE as necessary to calculate total daily caloric needs, which vary for active and inactive patients. Total energy expenditure (TEE) is equal to the REE times the appropriate physical activity factor. The physical activity factor for hospitalized patients or those confined to bed is 1.2; for non-hospitalized, sedentary patients, 1.3.

Table 1-5 Key Dietary Issues by Age and Disease

<table>
<thead>
<tr>
<th>Age/Disease</th>
<th>Key Dietary Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infants</td>
<td>Fluoride, iron, calories, protein, fat for growth and development</td>
</tr>
<tr>
<td>Children</td>
<td>Fluoride, iron, calcium, calories, protein, fat for growth and development</td>
</tr>
<tr>
<td>Teenagers</td>
<td>Iron, calcium, calories, protein for pubertal development (screen for eating disorders)</td>
</tr>
<tr>
<td>Pregnancy</td>
<td>Folate, iron, calcium, vitamin D, protein, appropriate weight gain</td>
</tr>
<tr>
<td>Alcoholism</td>
<td>Folate, thiamin, vitamin B₁₂, calories</td>
</tr>
<tr>
<td>Anemia</td>
<td>Iron, vitamin B₁₂, folate</td>
</tr>
<tr>
<td>Ascites</td>
<td>Sodium, protein</td>
</tr>
<tr>
<td>Beriberi</td>
<td>Thiamin</td>
</tr>
<tr>
<td>Cancer</td>
<td>Adequate protein, calories, and fiber</td>
</tr>
<tr>
<td>Celiac Disease</td>
<td>B complex, vitamins, vitamin D</td>
</tr>
<tr>
<td>COPD, Asthma</td>
<td>Vitamin D, calcium, weight loss, calories</td>
</tr>
<tr>
<td>Diabetes</td>
<td>Carbohydrates, saturated fat, cholesterol, calories, fiber</td>
</tr>
<tr>
<td>Heart Disease</td>
<td>Saturated fat, monounsaturated fat, cholesterol, sugar, fiber</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>Saturated fat, monounsaturated fat, cholesterol, sugar, fiber</td>
</tr>
<tr>
<td>Heart Failure</td>
<td>Sodium</td>
</tr>
<tr>
<td>Hypertension</td>
<td>Sodium, calcium, potassium, alcohol, sugar, total calories</td>
</tr>
<tr>
<td>Kidney Stones</td>
<td>Calcium, oxalate, uric acid, protein, sodium, fluid</td>
</tr>
<tr>
<td>Liver Disease</td>
<td>Protein, sodium, fluid</td>
</tr>
<tr>
<td>Malabsorption</td>
<td>Vitamins A, D, E and K</td>
</tr>
<tr>
<td>Obesity</td>
<td>Total calories, portion sizes, saturated fat</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>Vitamin D and calcium</td>
</tr>
<tr>
<td>Pellegra</td>
<td>Niacin</td>
</tr>
<tr>
<td>Renal Failure</td>
<td>Protein, sodium, potassium, phosphorous, fluid</td>
</tr>
<tr>
<td>Rickets</td>
<td>Vitamin D and calcium</td>
</tr>
<tr>
<td>Scurvy</td>
<td>Vitamin C</td>
</tr>
<tr>
<td>Vegetarian diet</td>
<td>Protein, vitamin B₁₂, iron, calcium</td>
</tr>
</tbody>
</table>

Source: Lisa A. Hark, PhD, RD and Darwin Deen, MD, MS. 2014. Used with permission.

Table 1-6 Definition of Energy/Calorie

Energy is expressed in kilocalories (kcal) and is produced by the oxidation of dietary protein, fat, carbohydrate, and alcohol.
- One gram of **protein** yields approximately 4 kcal.
- One gram of **carbohydrate** yields approximately 4 kcal.
- One gram of **fat** yields approximately 9 kcal.
- One gram of **alcohol** yields approximately 7 kcal.

A calorie is the amount of heat required to raise the temperature of 1 gram of water by 1 degree Celsius. A kilocalorie is the amount of heat required to raise the temperature of 1 kilogram of water by 1 degree Celsius.
Protein Needs of Hospitalized or Critically Ill Patients

Protein requirements in a critically ill patient depend on the degree of catabolic stress the patient is experiencing. Guidelines are as follows:

- In unstressed well-nourished individuals, protein needs range from 0.8 to 1.0 g/kg body weight per day.
- In post-surgical patients protein needs range from 1.5 to 2.0 g/kg body weight per day.
- In highly catabolic patients (burns, infection, fever), protein needs can be over 2 g/kg body weight per day.

Malnutrition

According to the World Health Organization (WHO), malnutrition affects all age groups across the entire lifespan, from conception to older adults. Health consequences range from intrauterine brain damage and growth failure to reduced physical and mental capacity in childhood to an increased risk of developing diet-related chronic diseases later in life.

Insufficient food intake results in loss of fat, muscle, and ultimately visceral tissue. This reduction in tissue mass is reflected in weight loss. The smaller tissue mass reduces nutritional requirements, likely reflecting more efficient utilization of ingested food and reduction in work capacity at the cellular level. The combination of decreased tissue mass and reduction in work capacity impedes homeostatic responses, including responses to illness or surgery. The stress of critical illness inhibits the body’s conservation response to malnutrition. In addition, undernourished individuals experience nutrient deficiencies and imbalances that exacerbate the reduction in cellular work capacity. Malnutrition is also associated with a decrease in the inflammatory response and immune function. These alterations result in increased morbidity and mortality among undernourished patients. Adequate nutrition is essential for reversing these physiological effects. Aggressive nutritional support, instituted early in critical illness, may reduce the adverse effects of malnutrition in the critically ill patient.

Etiology/Causes of Malnutrition

Decreased Oral Intake

Poverty, poor dentition, gastrointestinal obstruction, abdominal pain, anorexia, dysphagia, depression, social isolation, and chronic pain are some of the many possible causes of decreased oral intake.

Increased Nutrient Loss

Glycosuria, proteinuria, gastrointestinal bleeding, diarrhea, malabsorption, a draining fistula, or protein-losing enteropathy can result in nutrient losses.

Increased Nutrient Requirements

Hypermetabolism state or excessive catabolic processes can result in increased nutrient requirements. Common examples of situations that can dramatically