

Part VI

Modified Diets

Vegetarian Diets in Health Promotion and Disease Prevention

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Overview/Introduction

Vegetarianism is rapidly growing in popularity. Technically defined, vegetarians are individuals who do not eat any meat, poultry, or seafood.^{1,2} Estimates on the number of vegetarians in the United States vary greatly according to the definition of vegetarianism provided in the survey. True vegetarians make up about 1% of the population, representing approximately two million people, according to a 1997 poll.³ A higher percentage of teenagers than adults follow a vegetarian diet — almost 2%.³

Vegetarian dietary patterns can represent an exceptionally healthy way of eating. They are typically rich in vitamins, minerals, phytochemicals, and fiber while often also low in fat, saturated fat, and cholesterol.^{1,4} However, each individual diet will need to be assessed for its nutritional adequacy. This section provides some guidance in characterizing vegetarian dietary patterns, health benefits, and concerns as well as identifying sources of various nutrients that may be marginal in many vegetarian diets.

Characteristics of Vegetarian Eating Styles

When working with someone who follows a vegetarian diet, it is important to ask him a variety of questions about his usual dietary patterns. Many people consider themselves to be vegetarian if they eat non-flesh foods several days a week. Others claim to be vegetarians when they consume fish or poultry. [Table 40.1](#) lists the types of vegetarian diets and describes what foods fall into each category.

In popular culture, many diets incorporate principles of vegetarianism and may represent more restrictive ways of eating, as described in [Table 40.2](#). For the purposes of this section, “vegetarian” will refer to an individual following a lacto and/or ovo or vegan dietary pattern.

TABLE 40.1**Types of Vegetarian Diets**

Vegan	Consumes nuts, fruits, grains, legumes, and vegetables. Does not consume animal-based food products, including eggs, dairy products, red meats, poultry, or seafood. Some vegetarians may avoid foods with animal processing (honey, sugar, vinegar, wine, beer).
Lacto-Vegetarian	Consumes milk and other dairy products, nuts, fruits, grains, legumes, and vegetables. Does not consume eggs, red meats, poultry, or seafood.
Ovo-Vegetarian	Consumes eggs, nuts, fruits, grains, legumes, and vegetables. Does not consume milk or dairy, red meats, poultry, or seafood.
Lacto-Ovo Vegetarian	Consumes milk and other dairy products, eggs, nuts, fruits, grains, legumes, and vegetables. Does not consume red meats, poultry, or seafood.
Pollo-Vegetarian ^a	Not technically considered a vegetarian type of diet, although often referred to as “vegetarian” in popular culture. Consumes milk and other dairy products, eggs, nuts, fruits, grains, legumes, vegetables, and poultry.
Peche-Vegetarian also called pesco- and pecto-vegetarian ^a	Not technically considered a vegetarian type of diet, although often referred to as “vegetarian” in popular culture. Consumes milk and other dairy products, eggs, nuts, fruits, grains, legumes, vegetables, and seafood.
Omnivore	Consumes from a wide variety of foods, including meats, grains, fruits, vegetables, legumes and dairy products. Individuals who consume red meats (beef, pork, lamb, etc.), poultry, seafood, or any still or once living non-plant-based matter are not vegetarians.

^a This is not technically a vegetarian diet, although it is often referred to as such.

TABLE 40.2**Types of Popular Diets Incorporating Various Principles of Vegetarianism^a**

Fad diets	Popular weight loss diets often incorporate various principles of vegetarianism, although not generally in nutritious, balanced ways. The cabbage soup diet is an example, which is based on consuming only a vegetable soup based on cabbage as a weight-loss technique.
Fruitarian	Consumes botanical fruits (including nuts and seeds); avoids meats, poultry, seafood, dairy, eggs, and vegetables. May avoid legumes.
Macrobiotic	Largely based on grains and in-season foods, including vegetables (except those of the nightshade family), sea vegetables, soups, and beans. Nuts and seeds are not consumed on a daily basis; fruits are included with the exception of tropical fruits. Seafood is sometimes included as well. Asian foods contribute significantly to food choices. This is an example of a diet following a food-combining philosophy.
Natural hygiene or raw foods diet	Generally raw vegetables, fruits, whole grains or sprouted grains (in some cases may be cooked), sprouted or non-sprouted legumes, nuts, and seeds. Some individuals may consume raw dairy products. There is great variation in this diet plan: many followers do consume cooked foods, and some consume meat as well. This is an example of a diet following a food-combining philosophy, but has many variations among followers.

^a Many variations exist on each of these types of diets. This is not intended as a comprehensive listing.

Individuals following restrictive diets are more susceptible to dietary deficiencies and imbalances.^{1,2} [Table 40.3](#) describes the nutrients that may be of concern in many vegetarian diets.

Health Benefits and Risks of Vegetarianism

Most health risks associated with a vegetarian diet are found with strict vegetarianism (veganism) only, not with the more liberal forms of intake found in lacto-vegetarians, ovo-

TABLE 40.3

Nutrients Potentially at Risk in Vegetarian Diets; Dietary Reference Intakes (DRIs), Functions and Sources^{2,27-29}

Vitamin/ Mineral	DRI: adult value 19–50 yr old, non-pregnant	Function	Good Sources in Vegetarian Diet
<i>Vitamins</i>			
Vitamin B ₁₂	M: 2.4 µg F: 2.4 µg	Works with folic acid to make red blood cells; important in maintaining healthy nerve fibers; helps the body use fat and protein.	Dairy products, eggs, fortified cereals, fortified soy products/meat substitutes, fortified nutritional yeast.
Vitamin D	Adequate Intake (AI): M: 5 µg F: 5 µg	Promotes absorption of calcium and phosphorus and helps deposit them in bones and teeth.	Fortified milk; made in body when skin is exposed to sunlight.
Riboflavin (B ₂)	M: 1.3 mg F: 1.1 mg	Helps the body release energy from protein, fat, and carbohydrates.	Fortified dairy products, fortified breads and cereals, tomatoes, lima beans, raisins, avocado, beans, and legumes.
<i>Minerals</i>			
Calcium	AI: M: 1000 mg F: 1000 mg	Used to build bones and teeth and keep them strong; important in muscle contraction and blood clotting.	Dairy products, broccoli, mustard and turnip greens.
Iron ^a	M: 8 mg F: 18 mg	Carries oxygen in the body, both as a part of hemoglobin (in the blood), and myoglobin (in the muscles).	Whole-grain and enriched cereals, some dried fruits, soybeans.
Zinc	M: 11 mg F: 8 mg	Assists in wound healing, blood formation, and general growth and maintenance of all tissues; component of many enzymes.	Plant and animal proteins.
Manganese ^b	AI: M: 2.3 mg F: 1.8 mg	Found in most of body's organs and tissues, particularly in bones, liver, and kidneys. Serves as a cofactor in many metabolic processes. Deficiency not seen in human populations.	Whole grains, cereal products, tea, some fruits and vegetables.
Iodine	150 µg/d	Constituent of thyroid hormones (regulation of metabolic rate, body temperature, growth, reproduction, making body cells, muscle function, nerve growth).	Fortified in salt, found widely in processed foods and grains where soil concentration is adequate.
Copper ^c	900 µg	Necessary for the formation of hemoglobin; keeps bones, blood vessels, and nerves healthy.	Nuts, legumes, whole grains.
Selenium	55 µg	Antioxidant functions, role in eicosanoid metabolism, regulation of arachadonic acid and lipid peroxidation, some hormone conversions.	Eggs, whole grains, legumes, brazil nuts.
<i>Macronutrients and Other Dietary Components</i>			
Protein	RDA: Male: 63 g Female: 50 g or 0.8 gm/kg	Building of nearly all body tissues, particularly muscle tissue, energy.	Dairy products, legumes, meat analog products often made from soy; whole grains and vegetables are poorer sources.

TABLE 40.3 (Continued)

Nutrients Potentially at Risk in Vegetarian Diets; Dietary Reference Intakes (DRIs), Functions and Sources^{2,27-29}

Vitamin/ Mineral	DRI: adult value 19–50 yr old, non-pregnant	Function	Good Sources in Vegetarian Diet
Omega-3 fatty acids	Optimal intake estimated at 1-2 g/d; fatty acids should make up at least 3% of day’s energy intake.	One is called linolenic acid. Energy source, cell wall structure, may play a role in disease prevention. Fats also play a role in the absorption and transport of fat-soluble vitamins. Linolenic acid cannot be made by the body. Omega-3 series fatty acids can be found in grains, seeds, nuts, and soybeans, and the body can manufacture eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) from these precursors.	Fats and oils (bean, nut, and grain oils), nuts and seeds (butternuts, walnuts, soybean kernels), soybeans, flax seeds, and flax seed oil.

- ^a There is some evidence that vegetarian diets tend to be quite high in iron and that iron deficiency anemia is no more common among vegetarians than in meat eaters.¹
- ^b Manganese is not necessarily at risk for deficiency in vegetarians. Some research has indicated that vegetarians have a higher intake of this nutrient; however, bioavailability may be a concern.^{14,17}
- ^c Copper is not necessarily at risk for deficiency in vegetarians. Some research has indicated that vegetarians have a higher intake of this nutrient; however, bioavailability may be a concern.^{14,17}

vegetarians, or lacto-ovo vegetarians.^{1,5,6} Table 40.4 lists the health risks of vegetarianism, most of which are related to the potential for nutrient deficiencies found with this type of diet. These health risks are not unique to vegetarians, however, as they can be quite common in people following an imbalanced omnivorous diet.

Many vegetarians follow a dietary pattern that reduces their risks for common chronic diseases, as noted in Tables 40.5 and 40.6.⁴ New vegetarians, in particular, however, may rely heavily on dairy products which may actually increase risk for cardiovascular disease. Other practical concerns for new vegetarians are found in Table 40.7.

Table 40.8 compares the typical dietary intake of vegans and lacto-ovo vegetarians with omnivores; the health risks/outcomes associated with specific kinds of vegetarian diets are mentioned in Table 40.9. The nutrients of special concern will vary depending on the

TABLE 40.4

Health Risks of Vegetarianism^{1,5,7,13,22-26,30,31}

Dietary Factor	Risk
Calcium	Low calcium intake in vegan or macrobiotic diet can lead to low bone mineral density.
Iodine	A strict vegan consuming no iodized salt or processed food products can develop goiter.
Vitamin B ₁₂	In strict vegans or in the offspring of vegan mothers only, deficiency can lead to anemia, or in far more severe cases, neuropathy.
Energy	Impaired growth can result in infants and children with inadequate energy intake or those weaned to “homemade” formulas.
Docosahexaenoic acid (DHA)	Greatest concern for fetus and young infants. DHA is needed for neural and retinal development.
Dairy products	Limited evidence exists linking high consumption of dairy products to diabetes (type 1) primarily in infants and children, and to ovarian cancer in adults with galactose-1-phosphate uridylyltransferase defects.

TABLE 40.5Health Benefits of Vegetarianism^{1,2,4,10-13,19,32-34}*Lower Risk Of*

Cancer (particularly colon and lung)
 Obesity
 Heart disease
 Type 2 diabetes
 Hypertension
 Constipation and hemorrhoids
 Kidney stones
 Gallstones

Potential Lower Risk For (Limited Evidence Suggesting)

Arthritis
 Gout
 Dementia
 Tooth decay
 Duodenal ulcers

TABLE 40.6Protective Factors in the Typical Lacto-Ovo Vegetarian Diet^{1,4,10,18,20}

Higher fiber
 Lower fat, saturated fat, and cholesterol
 Higher folate intake
 Higher intake of antioxidants
 Higher intake of phytochemicals
 Lower intake of total and animal protein

TABLE 40.7

Practical Concerns about Vegetarianism

New vegetarians or those who are vegetarian for philosophical (as opposed to health) reasons may rely heavily on the use of dairy products and eggs.

Whole milk cheeses, 2% and higher fat content milk, eggs and whole milk yogurts are rich in fat, saturated fat, and in some cases cholesterol. These can contribute to higher risks for cardiovascular disease in particular, and should be evaluated.

Some adolescents with eating disorders may use vegetarianism as a rationalization for avoiding foods or entire food groups.

TABLE 40.8Nutrient Differences between Omnivore, Lacto-Ovo and Vegan Dietary Patterns^{1,2,33}

Dietary Component	Vegan	Lacto-ovo	Omnivore
Total fat	~30% fat	30-36% fat	34-38% fat
Saturated fat	Generally low saturated fat intake	Generally moderate saturated fat intake	Generally higher saturated fat intake
P/S ratio	High P/S	Mod P/S	Poor P/S
Cholesterol	0 mg	150-300 mg	400 mg
Fiber (g/d range)	Generally 50-100% higher than omnivores and higher than lacto-ovo vegetarians. (range: 16.1-55.3 g/d)	Generally 50-100% higher than omnivores (range: 5.2-74.4 g/d)	Generally low (range: 3.5-33.8 g/d)

TABLE 40.8 (Continued)Nutrient Differences between Omnivore, Lacto-Ovo and Vegan Dietary Patterns^{1,2,33}

Dietary Component	Vegan	Lacto-ovo	Omnivore
Carbohydrate (% total kcalories)	50-65%	50-55%	<50%
Protein	10-12% of calories (none from animal sources)	12-14% of calories (~1/2 from animal sources)	14-18% of calories (~2/3 from animal sources)
Cholesterol levels (mmol/L)	4.29	4.88	5.31
Folate (mcg/d ranges)	170-385	214-455	252-471
Blood pressure	112.5/65.3	111.8/68.8	120.8/76.4

TABLE 40.9Health Risks of Individuals Following Various Types of Vegetarian Diets^{1,2,33}

Type of Vegetarian Diet	Health Risk Profile	Nutrients at Greatest Risk
Vegan	Low risk of obesity, heart disease, cancer, hypertension, and diabetes. Vegans may have a lower health risk than lacto-ovo vegetarians due to the typical lower fat and higher fiber content than either lacto-ovo or non-vegetarians.	Vitamin B ₁₂ Vitamin D Calcium Zinc Energy Potentially Iron
Lacto-vegetarian	Generally low risk of obesity, heart disease, cancer, hypertension, and diabetes. Unskilled or new vegetarian may rely heavily on whole-milk based products, thus consuming high fat, saturated fat, and cholesterol intakes which could increase the risk of cardiovascular-related diseases.	Zinc Potentially Iron
Ovo-vegetarian	Generally low risk of obesity, heart disease, cancer, hypertension, and diabetes. Unskilled or new vegetarian may rely heavily on eggs and egg-based products, thus consuming high fat, saturated fat, and cholesterol intakes which could increase the risk of cardiovascular-related diseases.	Zinc Potentially Iron
Lacto-ovo vegetarian	Generally low risk of obesity, heart disease, cancer, hypertension, and diabetes. Unskilled or new vegetarian may rely heavily on whole-milk or egg-based products, thus consuming high fat, saturated fat, and cholesterol intakes which could increase the risk of cardiovascular-related diseases.	Zinc Potentially Iron

type of vegetarian diet followed. As discussed in [Table 40.10](#), some nutrients are more critical during specific developmental phases; deficiency of a particular nutrient at a particular stage of the life cycle can have dramatic consequences.^{5,7-9}

Energy and Macronutrients in the Vegetarian Diet

A common misconception about a vegetarian diet concerns protein. Many new vegetarians are frequently confronted with the question: “So how do you get your protein?” Individuals following a lacto-ovo vegetarian diet rarely have to worry about protein. Even vegans eating a reasonably balanced diet with adequate kcalories can easily meet their protein needs.^{1,4} In reality, it is much more likely that the individual is suffering from a dietary

TABLE 40.10Critical Periods of Importance for Selected Nutrients^{2,25,27}

Nutrient	Critical Periods during Lifecycle
Vitamin B ₁₂	Throughout, particularly critical during pregnancy, infancy, and childhood
Riboflavin (B ₂)	Pregnancy, periods of growth
Vitamin D	Childhood and pre-puberty, pregnancy, elderly
Calcium	Childhood and pre-puberty, elderly
Iron	Infancy, childhood, adolescence, pregnancy, adulthood (women particularly)
Zinc	Puberty, pregnancy, elderly
Iodine	Adolescence, pregnancy, lactation
Protein	Infancy, childhood, adolescence, pregnancy
Omega-3 fatty acids (especially DHA)	Pregnancy, infancy
Energy	Periods of growth, especially toddlers/preschoolers, due to small stomach capacity

TABLE 40.11Definitions Related to Protein Complementation²

Complete protein	Contains all essential amino acids in ample amounts; amino acid pattern is very similar to humans
Incomplete protein	May be low in one or more amino acids; amino acid pattern is very different from humans
Limiting amino acid	The essential amino acid(s) that are in the smallest supply in the food
Essential amino acid	Cannot be synthesized by the human body. Include: Arginine, Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine, Tryptophan, Valine

TABLE 40.12Limiting Essential Amino Acids and Vegan Sources^{1,2}

Food	Limiting Amino Acids	Vegan Sources of the Limiting Amino Acids
Legumes	Methionine, Cysteine	Grains, nuts, seeds, soybeans
Cereals/grains	Lysine, Threonine	Legumes
Nuts and seeds	Lysine	Legumes
Peanuts	Methionine, Lysine, Threonine	Legumes, grains, nuts, seeds, soybeans
Vegetables	Methionine	Grains, nuts, and seeds, soybeans
Corn	Tryptophan, Lysine, Threonine	Legumes, sesame and sunflower seeds, soybeans

deficiency of a micronutrient, such as calcium or zinc, than a protein deficiency. Energy and protein can be of concern in some adult vegetarian diets, particularly if the individual follows severe dietary restrictions, and in children.⁸

Tables 40.11 through 40.13 provide information about essential and non-essential amino acids and protein complementation. In the 1970s, carefully complementing proteins at each meal was thought to be the only way for vegetarians to avoid protein deficiency. We now know that it is not necessary to combine proteins at each meal,^{1,4} yet it is important to understand the terminology related to the body's protein needs and the principles of complementation.

Table 40.14 compares average protein intakes in the U.S., while Tables 40.15 and 40.16 provide information about protein and nutrient- and energy-dense food sources. As an arbitrary guideline, foods with 2 g or less of protein were not included. Information about nutrient- and energy-dense foods can be useful for young children who may fill up quickly on a bulky vegetarian diet without meeting their calorie and nutrient needs.⁹

TABLE 40.13Guidelines for Protein Complementation^{1,2}

Type of Vegetarian Diet	Guidelines for Complementation ^a
Lacto-ovo	Dairy and eggs provide complete protein, as do other animal products.
Vegan	A vegan diet that contains a variety of grains, legumes, vegetables, seeds, and nuts over the course of a day in amounts to meet a person's calorie needs will provide adequate amino acids in appropriate amounts. Soybeans match human needs for essential amino acids as precisely as animal foods, and are thus a complete protein.
Any	It is not necessary to combine proteins in each meal. Young children, however, may need to have the complementary proteins consumed within a few hours of each other.

^a All proteins except gelatin provide all of the amino acids. Some protein sources have relatively low levels of some amino acids, so a large amount of that food would need to be consumed if it were the only source of those "limiting" amino acids.¹

TABLE 40.14Protein Intakes in the United States¹

Type of Diet	Percent of Calories from Protein	Sufficient to Meet RDA?
Typical U.S. diet	14–18%	Yes
Lacto-ovo vegetarians	12–14%	Yes, provided adequate calories are consumed
Vegans	10–12%	Yes, provided adequate calories are consumed

TABLE 40.15Protein: Vegetarian Sources and Amounts^{27,35,36}Adult RDA: Males 63 g/day Females 50 g/day^a

Food	Portion Size	Protein (g)	Kcal
<i>Cereals/Grains</i>			
Quinoa	0.5 cup	11.1	318
Millet, cooked	1 cup	8.4	286
Wheat germ, toasted	0.25 cup	8.4	111
Bagel, plain	1 bagel	7.5	195
Couscous, cooked	1 cup	6.8	200
Macaroni, enriched, cooked	1 cup	6.7	197
Pita, whole wheat	1 pita	6.3	170
Grape-Nuts, Post	0.5 cup	6.0	200
Oatmeal Crisp, almond, General Mills	1 cup	6.0	220
Oatmeal, old fashioned, Quaker	0.5 cup dry	5.5	148
Oat bran, raw	0.33 cup	5.4	76
Brown rice, medium grain, cooked	1 cup	4.5	218
English muffin, plain	1 muffin	4.4	134
Barley, pearled, cooked	1 cup	3.5	193
Whole wheat bread	1 slice	2.7	69
Corn grits, instant, white, enriched	1 oz. packet dry	2.4	96
<i>Vegetables</i>			
Peas, green, canned	0.5 cup	3.8	59
Corn, yellow, boiled	0.5 cup	2.7	89
Broccoli, boiled	0.5 cup	2.3	22

TABLE 40.15 (Continued)Protein: Vegetarian Sources and Amounts^{27,35,36}Adult RDA: Males 63 g/day Females 50 g/day^a

Food	Portion Size	Protein (g)	Kcal
<i>Fruits</i>			
Prunes, dried	10 prunes	2.2	201
<i>Dairy/Soy milk</i>			
Cottage cheese, 1% fat	1 cup	28.0	164
Yogurt, lowfat (1.5% milk fat), plain, Breyers	1 cup	11.0	130
Simple Pleasures, chocolate	0.5 cup	8.9	134
Gruyere cheese	1 oz.	8.5	117
Milk, low fat (1%)	1 cup	8.0	102
Cheddar cheese	1 oz.	7.1	114
Soy milk	1 cup	6.6	79
American processed cheese	1 oz.	6.3	106
Pudding, all flavors, from instant mix Jell-O brand	0.5 cup	4.0	155
Frozen yogurt, soft serve	0.5 cup	2.9	115
Ice cream, vanilla, regular (10% fat)	0.5 cup	2.3	133
<i>Beans/Legumes</i>			
Soybean nuts, roasted	0.5 cup	30.3	405
Lentils, boiled	1 cup	17.9	230
Lima beans, boiled	1 cup	14.7	216
Kidney beans, canned	1 cup	13.3	207
Garbanzo beans, canned	1 cup	11.9	286
<i>Soy Products/Meat Substitutes</i>			
Tofu, raw, firm	0.5 cup	19.9	183
Tempeh	0.5 cup	15.7	165
Pepperoni from meat substitute	16 slices	14.0	70
Better 'n Burger, Morningstar Farms	1 patty	11.3	75
Soybeans, green, boiled	0.5 cup	11.1	127
Ground meatless, frozen, Morningstar Farms	0.5 cup	10.3	60
Meatless deli turkey	3 slices	9.0	40
<i>Nuts/Seeds</i>			
Peanut butter, chunk style/crunchy	2 T	7.7	188
Sunflower seeds, dried	1 oz.	6.2	160
Almonds, blanched	1 oz.	6.0	174
Sesame butter (tahini)	2 T	5.0	174
Cashews, dry roasted	1 oz.	4.3	163
<i>Eggs</i>			
Egg substitute, frozen	0.25 cup	6.8	96
Egg, chicken, whole, fresh/frozen	1 large	6.2	75
Egg, chicken, yolk fresh	1 large	2.8	61
<i>Mixed Foods</i>			
Frozen French bread pizza, vegetarian	6 oz. pizza	17.0	270
Shells & cheese, from mix	1 cup	16.0	360
Burritos w/ beans	2 burritos	14.1	447
Biscuit w/ egg	1 item	11.1	316
Potato, baked, w/ sour cream & chives	1 potato	6.7	393

^a Taking into account the lower digestibility and amino acid profile, a reasonable RDA for vegans is approximately 10% more protein than omnivores.¹

TABLE 40.16Vegetarian Sources of Energy-Dense, Nutrient-Dense Foods^{35,36}

Food	Portion Size	Kcal
<i>Cereals/Grains</i>		
Granola, low-fat	1 cup	422
Quinoa	0.5 cup	318
Millet, cooked	1 cup	286
Pancakes, Bisquick, blueberry	3 each	220
Oatmeal Crisp	1 cup	210
Grape-Nuts, Post	0.5 cup	200
Macaroni, enriched, cooked	1 cup	197
Bagel, plain	1 bagel	195
Raisin bran, dry	1 cup	175
Corn muffin (2.5 x 2.25 inch)	1 muffin	174
Pita, whole wheat	1 pita (6.5 in diameter)	170
Banana nut muffin, from mix	1 muffin	160
Oat bran muffin	1 muffin	154
<i>Vegetables</i>		
Tater Tots, frozen, heated	4 oz.	204
Potatoes, mashed from granules	1 cup	166
<i>Fruits</i>		
Avocado, California, raw	0.5 medium	153
Raisins, golden, seedless	0.66 cup	302
Mixed fruit, dried, diced, Delmonte	0.66 cup	220
<i>Dairy/Soy milk</i>		
Milkshake, thick vanilla	1 cup	256
Yogurt, flavored, lowfat, 1% milkfat, Breyers	1 cup	251
Ricotta cheese, part-skim	0.5 cup	171
Cottage cheese (1% fat)	1 cup	164
Pudding, all flavors, from instant mix Jell-O	0.5 cup	155
Milk, whole	1 cup	150
Yogurt, lowfat (1.5 % milk fat), plain, Breyers	1 cup	130
Cheddar cheese	1 oz.	114
Milk, low fat (1%)	1 cup	102
Soy milk	1 cup	79
<i>Beans/Legumes</i>		
Soybean, dried, boiled, mature	1 cup	298
Garbanzo beans, canned	1 cup	286
Lentils, boiled	1 cup	230
<i>Soy Products/Meat Substitutes</i>		
Soybean nuts (roasted)	0.5 cup	405
Tempeh	1 cup	330
Soyburger w/ cheese	1 each	316
Chicken nuggets, meatless	5 pieces	245
Frankfurter, meatless	1 each	102
<i>Nuts/Seeds</i>		
Peanut butter, chunky style	2 T	188
Almonds, blanched	1 oz.	174

TABLE 40.16 (Continued)Vegetarian Sources of Energy-Dense, Nutrient-Dense Foods^{35,36}

Food	Portion Size	Kcal
Sesame butter (tahini)	2 T	174
Sunflower seeds, dried	1 oz.	160
<i>Mixed Foods</i>		
Egg salad	1 cup	586
Burritos, w/ beans	2 burritos	447
Potato, baked, w/ sour cream and chives	1 potato	393
Shells & cheese, from mix	1 cup	360
Peanut butter and jam sandwich on wheat	1 each	344
Cheese enchilada	1 item	320
Biscuit w/ egg	1 item	316
Lasagna, no meat, recipe	1 piece	298
Chili, meatless, canned	0.66 cup	190
Trail mix, regular	0.25 cup	150
Vegetable soup	1 cup	145
Pizza, cheese	1/8 of 12-inch	140
Pasta with marinara sauce	1 cup	180-450

Micronutrients in the Vegetarian Diet

Although vegetarian dietary patterns can be extremely healthful,^{1,10,11-13} certain micronutrients can be challenging to obtain in sufficient quantities, depending on the specific dietary restrictions the individual follows. Tables 40.17 through 40.28 provide information about sources of micronutrients that can be of concern for some vegetarian individuals.^{1,4-7,11,13-17} As a guideline, foods with less than 5 to 10% of the recommended amount of that particular nutrient per serving were not included in the tables.

Bioavailability of minerals can influence the amount available for absorption. Tables 40.24 and 40.28 list factors that may enhance or inhibit the absorption of iron and zinc.

Non-Nutritive and Other Important Factors in the Vegetarian Diet

Typical vegetarian diets are rich in many beneficial non-nutritive factors such as dietary fiber and phytochemicals.¹⁸⁻²⁰ Tables 40.29 and 40.30 provide information about sources of these beneficial but non-nutritive factors.

Omega-3 fatty acids are a type of polyunsaturated fatty acid thought to reduce the risk of cardiovascular disease through their effects on triglyceride levels and platelet aggregation.^{2,21} One type of omega-3 fatty acid, alpha-linolenic acid, is an essential fatty acid and must be consumed in the diet to prevent deficiency. Two other types of omega-3 fatty acids are eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Omega-3 fatty acids may be of concern to vegetarians because although alpha-linolenic acid is found in many plant foods, EPA and DHA are not.¹ For healthy adults this is not usually a concern, because the body has the ability to manufacture EPA and DHA from alpha-linolenic acid,

TABLE 40.17

Riboflavin:^a Vegetarian Sources and Amounts^{28,35,36}

Adult RDA: Males 1.3 mg/day Females 1.1 mg/day

Food	Portion Size	Riboflavin (mg)	Kcal
<i>Cereals^{bc}/Grains</i>			
Raisin bran	1 cup (2.1 oz.)	0.678	175
Bran flakes	0.66 cup (1 oz.)	0.43	91.5
Corn flakes, Kellogg's	1 cup (1 oz.)	0.375	90
Bagel, plain	1 bagel (3.5 inch)	0.22	195
Sesame breadsticks	2 sticks	0.22	120
Pita, white	1 pita (6.5 inch diameter)	0.20	165
Lasagna noodles	2 oz. dry	0.20	210
Cornbread, homemade from low-fat milk	1 slice	0.19	173
Corn muffin (2.5 x 2.25 inch)	1 muffin	0.19	174
English muffin, wheat	1 muffin	0.17	127
English muffin, plain	1 muffin	0.16	134
Muffin, blueberry, homemade (2.75 x 2 inch)	1 muffin	0.16	163.5
Macaroni, enriched, cooked	1 cup	0.14	197
Wild rice, cooked	1 cup	0.14	166
Rye bread	1 slice	0.11	83
<i>Vegetables</i>			
Mushrooms, boiled	0.5 cup	0.23	21
Tomato puree, canned	1 cup	0.14	100
Sweet potatoes, baked, with skin	1 medium	0.14	117
Tomato, red, sun-dried	0.5 cup	0.13	69.5
Garden cress, boiled	0.5 cup	0.11	16
<i>Fruits</i>			
Raisins, golden seedless	0.66 cup	0.19	302
Banana	1 medium	0.11	105
Raspberries, raw	1 cup	0.11	60
Avocado, Calif. raw	0.5 medium	0.105	153
<i>Dairy/Soy milk</i>			
Yogurt, plain, lowfat	1 cup	0.493	209
Milk, whole	1 cup	0.395	150
Cottage cheese, 1% fat	1 cup	0.37	164
Milk, nonfat	1 cup	0.34	86
Feta cheese	1 oz.	0.24	75
Ricotta cheese, part-skim	0.5 cup	0.23	171
Soy milk	1 cup	0.17	79
Cheddar cheese, reduced fat	1 oz.	0.14	80
Cheddar cheese	1 oz.	0.11	114
Goat cheese, soft	1 oz.	0.11	76
<i>Beans/Legumes</i>			
Soybeans, boiled	1 cup	0.49	298
Kidney beans, canned	1 cup	0.18	207
Great northern beans, canned	1 cup	0.16	299
Pinto beans, boiled	1 cup	0.16	234
Lentils, boiled	1 cup	0.14	230

TABLE 40.17 (Continued)Riboflavin:^a Vegetarian Sources and Amounts^{28,35,36}

Adult RDA: Males 1.3 mg/day Females 1.1 mg/day

Food	Portion Size	Riboflavin (mg)	Kcal
<i>Soy Products/Meat Substitutes</i>			
Chicken nuggets, meatless	5 pieces	0.30	245
Vegetarian burger, grilled, Morningstar Farms	1 patty	0.24	140
Breakfast links, Morningstar Farms	2 links	0.22	63
Tofu, raw, firm	0.5 cup	0.13	183
<i>Nuts/Seeds</i>			
Almonds, dry roasted	1 oz.	0.17	166
<i>Eggs</i>			
Egg, chicken, boiled	1 large	0.298	89.9
Egg substitute, frozen	0.25 cup	0.188	52.8
<i>Mixed Foods</i>			
Bean burrito	2 each	0.61	447
Cheese enchilada	1 each	0.42	319
Egg omelet w/ onion, pepper, tomato, mushroom	1 each	0.344	125
Vegetarian chili, fat-free w/black beans, Health Valley	5 oz.	0.255	70
<i>Beverages</i>			
Coffee substitute w/ milk	0.75 cup	0.298	120
<i>Miscellaneous</i>			
Brewers yeast	1 T	0.342	22.6

^a Also called vitamin B₂.^b Most fortified breakfast cereals contain 0.43-0.51 mg per serving.^c Many "100% Natural" breakfast cereals are not enriched and contain 0.03-0.12 mg per serving.

although vegetarians still have lower levels of blood DHA.^{1,22} The fetus and young infant have a dramatically reduced ability to perform this conversion.²³ Because DHA is needed for brain and retinal development, some pregnant or breastfeeding vegetarian women may need to reduce their intake of linoleic acid (an omega-6 fatty acid) relative to their intake of alpha-linolenic acid to increase DHA levels, or they may choose to try DHA-enriched eggs or DHA supplements derived from microalgae, although the safety of this has not been established.²²⁻²⁶ [Table 40.31](#) lists vegetarian dietary sources of the omega-3 fatty acid alpha-linolenic acid.

The Effects of Cooking, Storage, and Processing on the Critical Nutrients

Cooking, storage, and processing methods can influence the amount of a nutrient present in a food. [Table 40.32](#) presents the effects of cooking, storage, and processing on the nutrients that may be of concern in a vegetarian diet.

TABLE 40.18Vitamin B₁₂: Vegetarian Sources and Amounts^{28,35,36}

Adult RDA: 2.4 µg/day

Food	Portion Size	Vitamin B12 (µg)	Kcal
<i>Cereals^a/Grains</i>			
Total, wheat	1 cup	7.00	116
Waffle, whole grain	2 each	3.11	154
Bran flakes	1 cup	2.49	152
Granola, lowfat	0.33 cup	1.50	120
Kix	1.5 cup	1.50	110
Corn flakes, dry	1 cup	1.27	92.9
Waffle, frozen, toasted	1 each	0.882	92.4
<i>Dairy/Soy milk^b</i>			
Soy milk, Edensoy Extra	1 cup	3.0	130
Cottage cheese, 1% fat	1 cup	1.43	164
Milk, skim	1 cup	0.93	86
Yogurt, flavored, lowfat 1% milkfat, Breyers	1 cup	0.90	251
Milk, whole	1 cup	0.87	150
Yogurt, whole, plain	1 cup	0.84	139
Yogurt, nonfat, flavored w/ aspartame, Light 'n Lively Free 70 Cal	1 cup	0.60	70
Buttermilk, cultured	1 cup	0.54	99
Feta cheese	1 oz.	0.479	74.8
Swiss cheese	1 oz.	0.476	107
Ricotta cheese, part-skim	0.5 cup	0.36	171
Havarti cheese	1 oz.	0.357	105
American processed cheese food	1 oz.	0.235	68.9
Cheddar cheese	1 oz.	0.23	114
<i>Soy Products/Meat Substitutes^c</i>			
Breakfast links	2 each	3.41	63
Soyburger w/cheese	1 each	1.72	316
Soyburger	1 each	1.70	142
Tempeh	1 cup	1.66	330
Breakfast patties	1 each	1.49	68
Chicken, meatless, breaded, fried patty	1 piece	0.95	177
<i>Eggs</i>			
Egg, chicken, boiled	1 large	0.56	78
<i>Mixed Foods</i>			
Spinach soufflé	1 cup	1.37	219
Cheese pizza	1 piece (1/8 of a 15-inch pie)	0.53	223
<i>Miscellaneous</i>			
Fortified nutritional yeast (Red Star T6635)	1 T	4.0	40

^a Some commercial cereals are not fortified with vitamin B₁₂; check labels carefully.

^b Subject to fortification; unfortified soymilk contains no vitamin B₁₂.

^c Subject to fortification; check labels of individual products carefully.

TABLE 40.19Vitamin D: Vegetarian Sources and Amounts^{28,35-37}

Adult Adequate Intake: 5 µg cholecalciferol (200 IU per day)

Food	Portion Size	Vitamin D (IU) ^a	Kcal
<i>Cereals/Grains</i>			
Raisin Bran	1 cup (2.1 oz.)	56	175
Corn Pops	1 cup	50	110
Lucky Charms	1 cup	44.8	125
Corn flakes	1 cup (1 oz.)	44	90
Granola, lowfat	0.33 cup	39.9	120
Wheat bran muffin from recipe w/ 2% milk	1 muffin (57 g)	25.1	161
Waffles, plain, recipe	1 each (75 g)	23.5	218
<i>Vegetables</i>			
Mushrooms, boiled	0.5 cup	59.3	21.1
<i>Dairy/Soy milk</i>			
Soy milk, Soy Moo, fat free, Health Valley	1 cup	100	110
Milk, nonfat	1 cup	98	85.5
Milk, whole	1 cup	97.6	150
Pudding, vanilla, instant, w/ whole milk	0.5 cup	49.0	162
<i>Eggs</i>			
Egg, chicken, boiled	1 large	26	78
Egg yolk, cooked	1 each	24.6	59.2
<i>Mixed Foods</i>			
Soup, tomato bisque, with milk	1 cup	49.2	198
Egg salad	0.5 cup	38.5	293
Egg omelet w/ mushroom	1 each (69 g)	36.4	91.2
<i>Fats/Oils/Dressings</i>			
Margarine, hard, hydrogenated soybean ^b	1 tsp.	19.9	29.8
<i>Desserts</i>			
Egg custard pie, frozen, baked	1 piece (105 g)	40.1	221
Chocolate-filled crepe	1 each (78 g)	28.1	119
Coffee cake, from mix	1 piece (72 g)	22.2	229

^a 1 IU vitamin D = 0.025 µg cholecalciferol.^b Subject to fortification; check labels.

TABLE 40.20Calcium: Vegetarian Sources and Amounts^{28,30,35,36}

Adult AI: Males 1000 mg/day Females 1000 mg/day

Food	Portion size	Calcium (mg)	Kcal
<i>Cereals/Grains</i>			
Calcium fortified cereal bars	1 bar (37 g)	200	140
<i>Vegetables</i>			
Collards, frozen, boiled	0.5 cup	179	31
Kale, frozen, boiled	1 cup	179	39
Turnip greens, canned	0.5 cup	138	16
Squash, acorn, baked	1 cup	90.2	115
Okra, boiled	0.5 cup	88	34
Squash, butternut, baked	1 cup	84	82
Broccoli, cooked	1 cup	72	44
Peas, green, cooked, from frozen	0.5 cup	19.2	62.4
<i>Fruits</i>			
Calcium-fortified orange juice	8 oz	300	120
<i>Dairy/Soy milk</i>			
Soy milk, fortified	8 oz (1 cup)	400	110
Malted milk, chocolate (Ovaltine)	8 oz	384	225
Evaporated milk, skim	4 oz	372	100
Evaporated milk, whole	4 oz	329	169
Goat's milk	8 oz (1 cup)	327	168
Yogurt, tofu yogurt, frozen	8 oz	309	254
Cow's milk, skim	8 oz (1 cup)	302	86
Cow's milk, 1/2%	8 oz (1 cup)	300	90
Cow's milk, 1%	8 oz (1 cup)	300	102
Yogurt, fat-free	8 oz	300	100
Yogurt, lowfat	8 oz	300	200
Yogurt, regular	8 oz	300	250
Cow's milk, 2%	8 oz (1 cup)	297	121
Cow's milk, whole	8 oz	290	150
Swiss cheese	1 oz	272	107
Cheddar cheese	1 oz	204	114
American cheese	1 oz	174	106
Mozzarella cheese, part skim	1 oz	183	72
Feta cheese	1 oz	140	75
Soy milk, non-fortified	8 oz (1 cup)	79.3	150
Cottage cheese, 1% fat	0.5 cup	69	82
<i>Beans/Legumes</i>			
Great northern beans	0.5 cup	60	105
<i>Soy Products/Meat Substitutes</i>			
Tofu, raw, firm	0.5 cup	258	183
Tempeh	1 cup	154	330
<i>Nuts/Seeds</i>			
Almonds, dried	1 oz (about 24 nuts)	75	167
<i>Desserts</i>			
Custard, 2% milk	1 cup	394	298
Sherbet, orange	1 cup	264	104
Soft serve ice cream, French vanilla	1 cup	226	370
Frozen yogurt, soft serve	1 cup	212	230
Ice cream, vanilla, regular, 10% fat	1 cup	168	226
<i>Miscellaneous</i>			
Blackstrap molasses	1 Tbsp	172	47

TABLE 40.21Copper:^a Vegetarian Sources and Amounts^{b 27,35,36}

Adult RDA: 900 µg/day

Food	Portion Size	Copper (mg)	Kcal
<i>Cereals/Grains</i>			
100% Bran	1 c	1.04	178
Granola, lowfat, Kellogg's	0.5 c	0.655	211
<i>Vegetables</i>			
Potatoes, baked, stuffed w/cheese	1 ea (254 g)	0.671	373
Vegetable juice cocktail, V-8	1 c	0.484	46.0
Potatoes, Baked, w/skin	1 ea (122 g)	0.372	133
<i>Fruits</i>			
Avocado, California	1 ea	0.460	306
Prunes, dehydrated, cooked	0.5 c	0.286	158
<i>Dairy/Soy Milk</i>			
Soy milk	1 c	0.288	79.2
<i>Beans/Legumes</i>			
Beans, adzuki, canned, sweetened	0.5 c	0.384	344
Garbanzo beans, boiled	0.5 c	0.289	135
<i>Soy Products/Meat Substitutes</i>			
Tempeh	1c	1.11	330
Scallops, meatless, breaded, fried	0.5 c	0.819	257
Luncheon slice, meatless	1 piece (67 g)	0.608	188
Soyburger w/cheese	1 ea	0.559	316
Tofu, raw, firm, calcium sulfate	0.5 c	0.476	183
<i>Nuts & Seeds</i>			
Cashew, dry roasted	0.25 c	0.76	197
Sunflower seeds, toasted	0.25 c	0.61	208

^a Severe copper deficiency is rare in humans with no dietary deficiency documented. Generally this is only seen with extended supplemental feeding/total nutrition through manufactured nutrition such as total parenteral nutrition, or impaired utilization.³⁶

^b High zinc intake (from supplements) can cause copper deficiency.²

TABLE 40.22Iodine: Vegetarian Sources and Amounts^{27,35,36}

Adult RDA 150 µg males and females

Food	Portion Size	Iodine (µg)	Kcal
<i>Cereals/Grains</i>			
Rice, white, enriched, cooked, long grain	0.5 c (82.5 g)	52	81
Bread, cornbread, homemade	1 piece (65 g)	44.2	176
Fruit-flavored, sweetened	1.1 oz (32 g)	41	120
Roll, white	2 rolls (38 g)	31	100
Muffin, blueberry/plain	1 ea (50g)	28.5	150
Tortilla, flour, 7-8" diam	1 ea (35 g)	26.3	114
Corn flakes	1 oz (28 g)	26	102
Bread, white	1 slice (28.4 g)	25.8	76.4
Pancakes, from mix, 4"	1ea (38 g)	21	74
Crisped rice	1 oz (28 g)	18.5	111
Noodles, egg, enriched, boiled	1 c (160 g)	17.6	213
Bread, whole wheat	1 slice (28 g)	17.6	69
Bread, rye, American	1 slice (32 g)	15.7	83
<i>Vegetables</i>			
Potato, boiled w/peel	1 ea (202g)	62.6	220
Fruit cocktail, heavy syrup, canned	0.5 c (128 g)	42.24	93
Potato, scalloped, homemade	0.5 c (122 g)	37.8	105
Navy beans, boiled	0.5 c (91 g)	35.5	129
Lima beans, baby, frozen, boiled	0.5 c (90 g)	27.9	95
Orange breakfast drink (from dry)	1 cup	27.3	114
Prunes, heavy syrup	5 ea (86 gm)	25.8	90
Cowpeas/blackeye peas	0.5 c (85 g)	22.1	112
<i>Dairy/Soy milk</i>			
Yogurt, lowfat, plain	1 cup	87.2	155
Buttermilk, skim, cultured	1 cup	60.0	99.0
2% fat milk	1 cup	56.6	137
Cottage cheese 1% fat	1 cup	56.5	164
Nonfat milk	1 cup	56.4	85.5
Whole milk, 3.3%	1 cup	56.1	150
Fruit yogurt, lowfat	1 cup	45.3	250
<i>Eggs</i>			
Fried in margarine	1 ea (46 g)	29	91.5
Scrambled, w/milk, in margarine	1 large, (61 g)	25.6	101
Soft-boiled	1 ea (50 g)	24	78
<i>Mixed Foods</i>			
Grilled cheese on wheat	1 ea (118 g)	28.9	392
Macaroni & cheese, box mix	0.5 c	17.3	199
<i>Condiments/Seasonings</i>			
Salt, Morton lite salt mixture	1 tsp	119	0

TABLE 40.23Iron: Nonheme Sources in the Vegetarian Diet^{27,35,36,38}

Adult RDA: Male 8 mg/Female: 18 mg

Food	Portion Size	Total Iron (mg)	Available Iron (mg) (where info available)	Kcals
<i>Cereals/Grains</i>				
Raisin Bran, dry	0.75 cup	Range: 18.54 to 3.7	0.19	200
Quinoa	1 cup	13.4	—	576
Corn flakes, dry	0.75 cup	6.5	0.32	90
Oatmeal, instant, fortified	0.5 cup	4.2	0.21	145
Special K	0.75 cup	3.4	—	75
Bran muffin	1 med	2.4	0.12	
Oatmeal, instant, regular	1 cup	1.59	—	145
Shredded Wheat, dry	1 oz	1.2	0.06	102
Bagel, enriched	1/2, 3.5" diameter	1.2	0.06	154
<i>Vegetables</i>				
Potato, baked, skin	1 med	2.8	0.14	220
Asparagus, pieces, canned	0.5 cup	2.21	—	23
Peas, cooked	0.5 cup	1.3	0.06	59
Spinach, boiled	0.5 cup	3.21	—	21
<i>Fruits</i>				
Prune juice	8 oz	3.02	—	182
Figs, dried	5 ea (93.5 g)	2.1	—	239
Raisins	2/3 c (100 g)	2.08	—	300
Prunes, dried	5 ea (42 g)	1.04	—	100
<i>Beans/Legumes</i>				
Split pea & carrot soup	7.5 oz	4.5	—	90
Lentil & carrot soup	7.5 oz	4.5	—	90
Black bean and carrot soup	7.5 oz	4.5	—	70
Kidney beans, boiled	0.5 cup	2.6	0.13	112
Navy beans, canned	0.5 cup	2.44	—	148
Chickpeas, boiled	0.5 cup	2.4	0.12	134
Soybeans, green, boiled	0.5 cup	2.25	—	127
Pinto beans, boiled	0.5 cup	2.23	—	117
Lima beans, cooked	0.5 cup	2.09	—	104
Pinto beans, canned	0.5 cup	1.94	—	93.6
Kidney beans, canned	0.5 cup	1.6	0.08	103
Chickpeas, canned	0.5 cup	1.6	0.08	143
<i>Soy Products/Meat Substitutes</i>				
Tofu, raw, regular,	~4 oz	6.65	0.32	94
Chili, made with meat substitute	0.67 cup	5.59	—	186
Garden burger	3.4 oz	2.89	—	186
Scallops, meatless, breaded, fried	.5 cup	1.77	—	257
Soyburger	1 each	1.49	—	142
Breakfast patties	1 each	1.42	—	97.3

TABLE 40.23 (Continued)Iron: Nonheme Sources in the Vegetarian Diet^{27,35,36,38}

Adult RDA: Male 8 mg/Female: 18 mg

Food	Portion Size	Total Iron (mg)	Available Iron (mg) (where info available)	Kcals
<i>Nuts/Seeds</i>				
Pumpkin seed kernel, roasted	.25 cup	8.45	—	296
Sunflower seeds, kernels, dry	.25 cup	2.44	—	205
Cashew, dry roasted	.25 cup	2.1	—	197
Coconut milk, canned	.25 cup	1.9	—	111
Almonds, dried, whole	.25 cup	1.3	—	209
Mixed nuts, dry roasted w/peanuts	.25 cup	1.27	—	204
<i>Miscellaneous</i>				
Molasses, blackstrap	1 Tbsp	3.5	—	47

TABLE 40.24Iron: Absorption Enhancers and Inhibitors^{1,2,38}

Class of Inhibitors	Examples	Found in	Effect on Iron Absorption
Polyphenols	Tannic acid, gallic acid, and catechin	Coffee, tea, red wines, certain spices, fruits, and vegetables	Coffee-35-40% Tea-60% Red wine-50%
Phytates	Substances that form insoluble complexes with nonheme iron	Whole grains, bran, soy products	
EDTA (ethylenediamine-tetraacetic acid)	Food additive used as sodium EDTA, calcium EDTA (prevents color changes and oxidation in foods)	Used broadly	Possibly up to 50% in some cases
Calcium	Calcium chloride (naturally occurring sources of calcium in self selected diets did not show an inhibitory effect; however there is a potential effect of other forms of calcium)	Additive to bread products, potential effect of other forms of calcium	Possibly up to 30-50% in some cases found with calcium chloride fortification
Fiber	Insoluble fibers, Phytate content may be responsible	Whole grains	Possibly 30-50%
Class of Enhancers ^a	Examples	Found in	Effect on Iron Absorption
Organic acids	Malic, ascorbic, citric, and bile acids	Found widely in foods	Enhances absorption
Amino acids	Some amino acids such as cysteine	Protein foods, also found widely in vegetables and grains	Enhances absorption

^a The presence of these acids with a meal will significantly improve iron absorption and in some cases potentially overcome the inhibitory effects of other components in foods.

TABLE 40.25Manganese:^a Vegetarian Sources and Amounts^{27,35,36}

Adult AI: Male 2.3 mg/Female 1.8 mg

Food	Portion Size	Manganese (mg)	Kcal
<i>Cereals/Grains</i>			
100% Bran	1 c	5.96	178
Most cereal	1 c	3.63	175
Grape Nuts	1 c	2.65	389
Bran Chex	1 c	2.53	156
All-Bran	0.33 c	2.39	70.7
Raisin Bran	1 c	2.16	175
Noodles, cooked, spinach	1 c	2.1	182
Noodles, cooked, macaroni, whole wheat	1 c	1.93	174
Rice flour, brown	0.25 c	1.59	144
Noodles, cooked, lasagna, whole wheat	2 ea	1.52	136
Wheat Chex	1 c	1.34	169
<i>Vegetables</i>			
Lima beans, boiled	0.5 c	1.07	105
<i>Fruits</i>			
Pineapple, chunks	1 c	2.56	76.0
Blackberries	1 c	1.86	74.9
<i>Soy Products/Meat Substitutes</i>			
Tofu, raw, firm, w/Nigari	0.5 c	1.49	181
Tempeh	0.5 c	1.19	165

^a Manganese is not necessarily at risk for deficiency in vegetarians. Some research has indicated that vegetarians have a higher intake of this nutrient; however, bioavailability may be a concern.^{14,17}

TABLE 40.26Selenium:^a Vegetarian Sources and Amounts^{27,35,36,39}

Adult RDA: 55 µg/day

Food	Portion Size	Selenium (µg)	Kcal
<i>Cereals/Grains</i>			
Special K, Kellogg's	1 cup	54.9	100
Bagel, plain, toasted	1 each	22.7	195
Granola, lowfat	1 cup	22.5	422
Pita pocket, 100% whole wheat, toasted	1 each	20.2	120
Barley, whole, cooked	0.5 cup	18.2	135
Pita pocket, white	1 each	18	165
Egg noodles, cooked	0.5 cup	17.4	107
Spaghetti/macaroni, enriched, cooked	0.5 cup	14.9	98.5
Puffed wheat	1 cup	14.8	44.4
Whole wheat bread	1 slice	12.8	86.1
Oatmeal, instant, prepared	0.5 cup	12.68	159
Buns, hamburger-style	1 each	12.5	129
English muffin, plain	1 each	11.5	134
Cheerios	1.25 cup	10.6	111
Matzo, whole wheat	1 each	9.89	99.5

TABLE 40.26 (Continued)Selenium:^a Vegetarian Sources and Amounts^{27,35,36,39}

Adult RDA: 55 µg/day			
Food	Portion Size	Selenium (µg)	Kcal
Brown rice, long grain	0.5 cup	9.6	108.5
<i>Vegetables</i>			
Brussels sprouts, boiled	1 cup	21.1	60.8
Cucumbers, slices with peel	0.5 cup	6.19	6.76
Mushrooms, raw	5 pieces	14.3	32.4
<i>Fruits</i>			
Grapes, Thompson seedless	0.5 cup	7.7	57
Applesauce, canned	0.5 cup	6.5	52.5
<i>Dairy/Soy milk</i>			
Cottage cheese, 1%	1 cup	13.6	164
Yogurt, fruit, lowfat (12 g protein/8 oz.)	1 cup	8.09	155
Milk, nonfat	1 cup	5.15	85.5
Frozen yogurt, chocolate, nonfat	1 cup	5.02	208
<i>Beans/Legumes</i>			
Black beans, dry, boiled	1 cup	13.7	227
Lima beans, cooked	1 cup	8.19	229
Great northern beans, cooked	1 cup	7.26	209
Chickpeas, boiled	1 cup	6.10	269
<i>Soy Products/Meat Substitutes</i>			
Tofu	0.5	1.79	94.2
<i>Nuts/Seeds</i>			
Brazil nuts, dried	0.25 cup	1036	230
Sunflower seeds, kernels, dry	0.25 cup	21.4	205
Cashew, dry roasted, unsalted	0.25 cup	8	197
<i>Eggs</i>			
Egg, hard cooked	1 each	10.7	77.5
Egg yolk, cooked	1 each	7.50	59.2
Egg white, cooked	1 each	5.88	16.6
<i>Mixed Foods</i>			
Lasagna, no meat, recipe	1 piece (218 g)	29.9	298
Avocado & cheese sandwich on wheat bread	1 each	25.2	456
Peanut butter and jam sandwich on wheat	1 each	24.3	344
Pizza, cheese	1/8 of 15-inch (120 g)	20.0	268
Bean burrito	1 each	14.1	223.5
Cucumber & vinegar salad	1 cup	11.1	47.8
<i>Desserts</i>			
Coffee cake, from mix	1 piece (72 g)	11.0	229
Carrot cake, w/ cream cheese icing, recipe	1 piece (112 g)	9.91	488

^a Selenium content of foods can vary widely, according to the selenium content of the soil.³⁹

TABLE 40.27Zinc: Vegetarian Sources and Amounts^{27,35,36,40}

Adult RDA: Males 11 mg/Females 8 mg

Food	Portion size	Zinc (mg) ^{a,b}	Kcal
<i>Cereals/Grains</i>			
Just Right	1 cup	22.8	152
Product 19, Kellogg's	1 cup	15	100
Complete bran	1 cup	8.07	195
100% Bran	1 cup	5.74	178
Raisin bran, dry	1 cup	5.71	175
Bran flakes	1 cup	5.15	127
Cap'n Crunch	1 cup	4.00	156
Granola, lowfat	0.33 cup	3.74	120
Quinoa	1 cup	3.4	576
Muffin, wheat bran, from recipe with 2% milk	1 each (57 g)	1.57	161
Noodle, spaghetti, spinach, cooked	1 cup	1.53	182
Bagel, oat bran	1 each	1.42	173
Pancakes, Aunt Jemima, blueberry	3 each (106 g)	1	246
<i>Vegetables</i>			
Palm hearts, cooked	1 cup	5.45	150
<i>Dairy/Soy milk</i>			
Soy milk	1 cup	2.90	150
Frozen, nonfat, chocolate yogurt	1 cup	2.18	208
Ricotta cheese, part-skim	0.5 cup	1.66	170
Edam/ball cheese	1 oz.	1.07	101
Buttermilk, cultured	1 cup	1.03	99
<i>Beans/Legumes</i>			
Adzuki, cooked	1 cup	4.07	294
Lentils, cooked	1 cup	2.52	230
Blackeye peas, boiled from dry	1 cup	2.22	198
Soybean, dried, boiled	1 cup	2.0	298
Kidney beans, red, cooked	1 cup	1.89	225
Chickpeas, canned	0.5 cup	1.28	143
<i>Soy Products/Meat Substitutes</i>			
Natto	1 cup	5.32	371
Miso	0.5 cup	4.60	284
Tempeh	1 cup	3.02	330
Tofu, raw, firm	0.5 cup	1.98	183
Chili with meat substitute	0.66 cup	1.67	186
Meatless scallops, breaded, fried	0.5 cup	1.24	257
Luncheon slice, meatless	1 piece	1.07	188
<i>Nuts/Seeds</i>			
Pumpkin seeds, kernel, dry roasted	0.25 cup	2.58	187
Cashew, dry roasted,	0.25 cup	1.9	197
Almonds, dry roasted	0.25 cup	1.7	203
Sunflower seeds, kernels, dry roasted	0.25 cup	1.7	186
Sesame butter/tahini from unroasted kernels	1 T	1.58	91.1
Peanuts, dry roasted	0.25 cup	1.2	214
Peanut butter, natural	2 T	1.06	187

TABLE 40.27 (Continued)

Zinc: Vegetarian Sources and Amounts^{27,35,36,40}

Adult RDA: Males 11 mg/Females 8 mg

Food	Portion size	Zinc (mg) ^{a,b}	Kcal
<i>Eggs</i>			
Egg substitute	0.5 cup	1.6	74
<i>Mixed Foods</i>			
Cheese enchilada	1 each	2.51	319
Avocado & cheese sandwich on wheat bread	1 each	1.83	456
Pizza, cheese	1/8 of 15-inch	1.56	268
<i>Desserts</i>			
Nutrigrain bar, fruit filled	1 each	1.5	150
Pecan pie, 1/8 of a 9" pie	1 piece (122 g)	1.26	503
Trail mix, regular	0.25 cup	1.21	173
Doughnut, eggless, carob-coated, raised	1 piece (78 g)	1.14	285

^a Zinc content of foods is influenced by genetic breeding and fertilizer and soil conditions.

^b Bioavailability is greater from animal than plant sources.⁴⁰

TABLE 40.28

Zinc: Absorption Enhancers and Inhibitors^{1,2,40}

Possible Absorption Enhancers ^a	Sources	Possible Absorption Inhibitors ^b	Sources
Yeast (acts by reducing phytates)	Fermented bread dough	Phytates	Whole grains (rye, barley, oatmeal, wheat), soy products
Animal protein	Animal products	Oxalate	Spinach, Swiss chard, leek, kale, collard greens, okra, rhubarb, raspberries, coffee, chocolate, tea, peanuts, pecans
Histidine	Amino acid widely distributed in foods containing protein	Fiber	Whole grains, fruits, vegetables, legumes
Albumin	Widely distributed in foods containing protein, egg white	Non-heme iron	Legumes, fortified cereals, leafy greens
		Copper	Legumes, whole grains, nuts, seeds, vegetables
		Calcium supplements	Over-the-counter supplements, multivitamins, some antacids
		High iron intakes relative to zinc intake	

^a Yeast is the only non-controversial zinc absorption enhancer.

^b Phytates are the only non-controversial zinc absorption inhibitor.

TABLE 40.29Fiber: Types, Functions, and Sources^{1,2,36}

Type of Fiber	Fiber Type	Food Sources	Function
Cellulose	Insoluble	Whole wheat flour, bran, cabbage, peas, green beans, broccoli, cucumbers, peppers, apples, carrots	Increases stool bulk and water absorption, decreases transit time through the GI system
Hemicellulose	Insoluble	Bran cereals, whole grains, brussels sprouts, greens, beet root	
Lignin	Insoluble	Breakfast cereals, bran, older vegetables, strawberries, eggplant, pears, green beans, radishes	
Gums	Soluble	Oatmeal, oat products, dried beans, oat bran, barley	Binds to bile acids and certain lipids to help lower blood cholesterol levels, metabolized to short chain fatty acids in gut which may play a role in signaling hepatic slowed cholesterol production
Pectin	Soluble	Squash, apples, citrus fruits, cauliflower, cabbage, dried peas and beans, carrots, strawberries	

TABLE 40.30Common Phytochemicals^a in Foods¹⁸

Chemical Names	Sources	Proposed Mechanism of Action
Sulforaphane	Isothiocyanates found in broccoli, cauliflower, cress, cabbages, radishes	Activates phase II enzymes in liver (removes carcinogens from cells)
Flavonoids	Citrus fruits and berries	Blocks the cancer-promotion process May inhibit the growth of early cancers
Monoterpenes (polyphenols)	Perillyl alcohol in cherries Limonene in citrus Ellagic acid in strawberries & blueberries	
Genistein	Soybeans, tofu	Prevents the formation of capillaries required to nourish tumors
Indoles	Cruciferous vegetables (broccoli, cauliflower, cress, cabbages, radishes)	Increase immunity, facilitate excretion of toxins
Saponins	Kidney beans, chickpeas, soybeans, lentils	May prevent cancer cells from multiplying
Lycopene	Tomatoes	May fight lung cancer

^a More than 10,000 phytochemicals are thought to exist. This table represents only a partial listing.

General Vitamin and Mineral Deficiency and Toxicity Symptoms

It is important for practitioners to be aware of the symptoms of nutrient deficiencies in any patient. As a group, vegetarians tend to be more health-conscious and knowledgeable about nutrition than the general public.¹ Some vegetarians choose megadoses of vitamins or minerals to combat real or perceived threats to their health. Therefore, toxicity may be more of a risk than a nutrient deficiency. [Table 40.33](#) presents deficiency and toxicity symptoms of the nutrients potentially deficient in a vegetarian diet.

TABLE 40.31Omega-3 Fatty Acids: Vegetarian Sources and Amounts^{2,29,41}Reasonable intake: 0.5%-1% of total calorie intake
(represents 1.1-2.2 g on a 2000 kcal diet)

Food	Portion Size	Alpha-linolenic Acid (18:3) (mg)	Kcal
<i>Cereals/Grains</i>			
Oats, germ	0.25 cup	0.4	119
Wheat germ	0.25 cup	0.2	104
Barley, bran	0.25 cup	0.1	115
<i>Vegetables</i>			
Soybeans, green, raw	0.5 cup	4.1	188
Kale, raw, chopped	1 cup	0.13	21
Broccoli, raw, chopped	1 cup	0.1	24
Cauliflower, raw	1 cup	0.1	26
<i>Fruits</i>			
Avocados, California, raw	1 medium	0.173	306
<i>Dairy/Soy milk</i>			
Cheese, Roquefort	1 oz.	0.2	105
<i>Beans/Legumes</i>			
Soybeans, dry	0.5 cup	1.5	387
Beans, pinto, boiled	1 cup	0.2	234
<i>Nuts/Seeds</i>			
Butternuts (dried)	1 oz.	2.4	174
Walnuts, dried, English/Persian	1 oz.	1.9	182
<i>Fats/Oils/Dressings</i>			
Linseed oil	1 T	7.5	124
Flax seed	1 T	2.2	124
Canola oil (rapeseed oil)	1 T	1.6	124
Walnut oil	1 T	1.5	124
Salad dressing, comm., mayonnaise, soybean	2 T	1.38	116
Soybean oil	1 T	1.0	124
Wheat germ oil	1 T	1.0	124
Salad dressing, comm., Italian, regular	2 T	1.0	140

TABLE 40.32Effects of Cooking, Storage, and Processing on the Critical Nutrients²

Nutrient	Cooking	Storage	Processing
Riboflavin	Stable to heat	Destroyed by light and irradiation	—
Vitamin B ₁₂	Some losses (30%)	Stable	Small losses (10%)
Copper	Increased content using water from copper pipes	Canning with copper adds content to the food	—
Iron	Cooking in iron vessels increases iron content of foods	—	—
Omega 3 fatty acids (a polyunsaturated fatty acid)	Stable in baking; unstable if smoking point is reached	May go rancid with prolonged storage	—

TABLE 40.33General Vitamin and Mineral Deficiency and Toxicity Symptoms^{2,14,27,37}

Vitamin/Mineral ^a	Deficiency Symptoms ^b	Toxicity Symptoms ^c
<i>Vitamins</i>		
Vitamin D	Children — rickets Adults — osteomalacia	Excessive bone and soft tissue calcification (lung, kidney, kidney stones, tympanic membrane) Hypercalcemia with symptoms of headache, weakness, nausea and vomiting, constipation, polyuria, polydipsia In infants: retarded growth, gastrointestinal upsets, and mental retardation
Vitamin B ₁₂	Pernicious (megaloblastic) anemia Smooth red tongue Fatigue Skin hypersensitivity (numbness, tingling and burning of the feet, stiffness and generalized weakness of the legs) Degeneration of peripheral nerves progressing to paralysis Other (glossitis, hypospermia)	Physiological stores substantial (~2000 µg). Stores and enterohepatic recycling may prevent deficiency symptoms for several years (~5) in the absence of intake None known up to 100 µg/d. No known benefit to high doses
Riboflavin (vitamin B ₂)	Anemia (normocytic, normochromic) Neuropathy Purple/magenta tongue General B-vitamin deficiency symptoms (soreness and burning of lips, mouth, and tongue) Cheilosis, glossitis, angular stomatitis, seborrheic dermatitis of nasolabial fold, vestibule of the nose, and sometimes the ears and eyelids, scrotum, and vulva	None known
<i>Minerals</i>		
Calcium	Bone deformities including osteoporosis, tetany, hypertension	Hypercalcemia of soft tissues and bone (children and adults) Poor iron and zinc absorption (of particular concern during pregnancy)
Iron	Hypochromic, microcytic anemia Seen across populations, particularly in women, children, and those from low socioeconomic status Fatigue Spoon-shaped nails	Seen at 100 mg intake Constipation Liver toxicity Infections Hemochromatosis Potential increased risk for heart disease and myocardial infarction
Zinc	Growth retardation resulting in short stature, mild anemia, low plasma zinc levels, and delayed sexual maturation Possible in diets very rich in fiber and phytate, which chelates the zinc in the intestine, thus preventing absorption Poor taste acuity, poor wound healing, night blindness, baldness, and skin lesions have also been reported	Toxicity is rare (300 mg/d) Continuous supplementation with high dose zinc can interfere with copper absorption Supplementation of 50 mg/c may decrease HDL Zinc sulfate at 2 g/d can result in nausea, vomiting, diarrhea, dizziness Iron and copper losses in urine with doses as low as 25 mg/day and if large doses (10-15× the RDA) are taken for even short periods of time

TABLE 40.33 (Continued)General Vitamin and Mineral Deficiency and Toxicity Symptoms^{2,14,27,37}

Vitamin/Mineral ^a	Deficiency Symptoms ^b	Toxicity Symptoms ^c
Copper	Severe copper deficiency: rare in humans Adults: neutropenia and microcytic anemia Children: neutropenia and leukopenia Decrease in serum copper and ceruloplasmin levels followed by failure of iron absorption leading to microcytic, hemochromic anemia Neutropenia, leukopenia, and bone demineralization are later symptoms Deficiencies have not been reported in otherwise healthy humans consuming a varied diet.	Rare — seen in genetic diseases such as Wilson's disease (genetic deficiency in liver synthesis of ceruloplasmin)

^a Absorption of some nutrients is affected by concentration of others; intestinal absorption of some nutrients is competitive.

^b Deficiency can result from inadequate provision in the diet or via inadequate absorption.

^c Toxicity is typically from overuse of nutritional supplements, although in some cases can be the cause of improper food fortification procedures (such as milk vitamin D fortification problems that arose in 1992).

Sample Meal Plans

Tables 40.34 through 40.37 present sample meal plans for adults and children following a lacto-ovo or vegan diet. These menus provide the Recommended Dietary Allowances (RDA) for energy and protein while presenting an appropriate macronutrient breakdown.

TABLE 40.34Sample Meal Plan for Lacto-Ovo Vegetarian Adult^{35,36}

Kcals: 2218; Carbohydrate: 374 g (67.35%); Protein: 100 g (18.); Fat: 55 g (22.29%)		
<i>Breakfast</i>	<i>Lunch</i>	<i>Dinner</i>
Raisin Bran (1 cup, 2.15 oz)	Whole wheat bread, 2 slices	Bean burrito
Milk, 1% fat, .75 cup (for cereal)	Griller veg. burger patty, 1 each	Black beans, 1 cup
Milk, 1% fat, 1 cup (beverage)	Mustard	Corn tortilla, 2 each, 6"
Orange juice, 1 cup	Tomato, sliced, 1/2 tomato	Rice, brown, 1 cup
Banana, 1 med	Jack cheese, 1 oz	Salsa, 2 Tbsp
	Apple, 1 med	Sour cream, 1 Tbsp
		Cheddar cheese, 1 oz
		Green salad, 2 cups
		Vinegar & oil dressing (1 tsp olive oil)
		Broccoli, 1 cup
		Milk, 1% fat, 1 cup
<i>Snack</i>		
Cereal bar, raspberry		
Dried apricots, 10 halves		

TABLE 40.35Sample Meal Plan for Vegan Adult^{35,36}

Kcals: 2217; Carbohydrate: 350g (63%); Protein: 90g (16%); Fat: 62g (25%)

<i>Breakfast</i>	<i>Lunch</i>	<i>Dinner</i>
Raisin Bran (1 cup, 2.15 oz)	Whole wheat bread, 2 slices	Bean Burrito
Soy milk, 1% fat, 1 cup (for cereal)	Griller veg. burger patty	Black beans, 1 cup
Soy milk, 1% fat, 1 cup (beverage)	(Morningstar Farms), 1 each,	Corn tortilla, 2 each, 6"
Orange juice, 1 cup, Ca fortified	cooked	Rice, brown, 1 cup
Banana, 1 med	Mustard	Salsa, 2 Tbsp
	Tomato, sliced, 1/2 tomato	Walnuts, ground, .5 oz
	Almonds, slivered, blanched, 1 oz	Green salad, 2 cups
	Apple, 1 med	Vinegar & oil dressing (1 tsp olive oil)
		Broccoli, 1 cup
		Soy milk, 1 cup
 <i>Snack</i>		
Cereal Bar, raspberry		
Dried Apricots, 10 halves		

TABLE 40.36Sample Meal Plan for Vegan Child Age 4 to 6^{35,36}

Kcals: 1864; Carbohydrate: 283 g (60.8%); Protein: 68 g (14.5%); Fat: 62 g (30%)

<i>Breakfast</i>	<i>Lunch</i>	<i>Dinner</i>
1 packet instant oatmeal	0.5 cup hummus spread made from	veggie hot dog on bun
8 oz soymilk fortified with calcium	chickpeas and sesame butter	0.5 cup mashed potatoes
and vitamin B ₁₂	2 slices whole wheat bread	0.5 cup cooked "creamed" spinach
1 banana	6 oz. 100% orange pineapple	0.5 cup applesauce
	banana juice	8 oz soymilk
	carrot sticks	
	2 molasses cookies	
 <i>Snack</i>		
4 oz fortified soymilk	1.5 oz (approx. 0.25 cup) trail mix	
4 graham crackers	4 oz fortified soymilk	

TABLE 40.37Sample Meal Plan for Lacto-Ovo Vegetarian Child Age 4 to 6^{35,36}

Kcals: 1794; Carbohydrate: 255 g (57%); Protein: 63 g (14%); Fat: 63 g (31.5%)

<i>Breakfast</i>	<i>Lunch</i>	<i>Dinner</i>
1 cup Honey Nut Cheerios with 4	0.5 cup homemade macaroni and	burrito with salsa and sour cream,
oz milk on cereal	cheese	made with vegetarian chili
4 oz 1% milk to drink	celery sticks and 2 Tbsp peanut	0.5 cup rice
orange slices	butter	4 oz 1% milk
	2 fruit cookies	0.5 cup green salad with broccoli
		0.5 cup applesauce
 <i>Snack</i>		
1.5 oz cheese	fruit smoothie made with juice,	
5 Ritz crackers	frozen yogurt, and fruit	
4 oz 1% milk		

Summary

In summary, the term “vegetarianism” may mean different things to different people. Before making or accepting generalizations about vegetarianism, it is important to define the term. A person following a vegetarian lifestyle can have significantly lower risks of many chronic diseases, such as heart disease or cancer, than an omnivore does. However, some nutrients are more difficult to easily obtain from a vegetarian diet and may be a concern for deficiency, especially in children or during other critical life-cycle periods.

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