

Plant-Based Diets

LEARNING OBJECTIVES

- ▶ Compare and contrast the types of vegetarian and semi-vegetarian diets **(Infographic C.1)**
- ▶ Describe the steps that occur during the development of cancer **(Infographic C.2)**
- ▶ List the recommendations that reduce the risk of cancer **(Infographic C.3)**
- ▶ Provide examples of two specific phytochemicals and their significant dietary sources **(Infographic C.4 and Infographic C.5)**
- ▶ Identify challenges that vegetarians may experience in meeting their requirements for specific nutrients, and provide strategies to overcome these challenges **(Infographic C.6 and Infographic C.7)**
- ▶ Describe the rationale for protein complementation, and give two examples of complementary protein foods **(Infographic C.8)**
- ▶ Compare and contrast the dietary recommendations and potential benefits of a vegetarian and a Mediterranean diet **(Infographic C.9)**

In April 2013, a team of researchers published the results of a rigorous randomized controlled clinical trial that *Forbes* magazine proclaimed would “undoubtedly have a major effect in the field of nutrition.” The scientists, based in Spain, had spent years investigating the impact of a Mediterranean-like diet on the risk of heart attack, stroke, and death from heart disease compared with the effect of a traditional low-fat diet, the latter of which has long been recommended for its heart-healthy benefits in the United States and elsewhere.

California Walnut Commission





Pass the Plants, Please

WHAT DOES A SPANISH STUDY SAY ABOUT THE BENEFITS OF FOLLOWING A MEDITERRANEAN-LIKE DIET?

PLANT-BASED DIETS

In the study they called PREDIMED (Prevention with Mediterranean Diet), the Spanish researchers assigned nearly 7500 people at high risk of heart disease to three different groups. Two of the groups were told to eat a Mediterranean-like diet (based on the traditional Mediterranean pattern of eating)—rich in fruit, vegetables, nuts, olive oil, and whole grains and low in processed and red meats, dairy products, and sweets—whereas people in the third group, the control group, were told to reduce their intake of all types of fat and consume lean meats, low-fat dairy products, cereals, potatoes, pasta, rice, fruits, and vegetables. Individuals in one of the Mediterranean-like diet groups were given weekly gifts of high-quality olive oil to encourage their consumption of this rich source of monounsaturated fat, whereas participants in the other Mediterranean-like diet group were given weekly gifts of mixed nuts to foster an increase of their nut intake.

Although the researchers had planned to observe the individuals and collect data for five years, the trial was so successful that they had to stop it short. The Mediterranean-like diet seemed to work *so well* to prevent heart attacks, strokes, and heart disease-related deaths that it would have been considered unethical to allow the people in the control group to

continue their assigned low-fat regimen, which was clearly much less effective. Indeed, those following the Mediterranean-like diet who were given olive oil had a 30% reduced risk of heart problems over the five-year period compared with the low-fat dieters, whereas those who had been given mixed nuts had a 28% reduced risk of heart problems or heart-related death compared with the low-fat dieters.

Lead researcher Emilio Ros says he was quite surprised by the diet's efficacy, considering that the people eating the Mediterranean-like diet weren't directed to do other heart-healthy things, such as limit their caloric intake or exercise. The trial showed "that a healthy dietary pattern such as the Mediterranean-like diet is as potent as modern drugs to reduce cardiovascular risk."

Since the publication of the Spanish study, evidence continues to support the protective effect of the Mediterranean diet. A 2017 meta-analysis showed an average risk reduction of 40% for coronary heart disease, myocardial infarction (heart attack), and stroke. The intake of olive oil, fruits, vegetables, and legumes inherent in the traditional Mediterranean eating style appear to account for most of the protective effect.



Two groups of participants in the Spanish PREDIMED study consumed daily servings of either nuts or olive oil.



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A **Mediterranean diet** can be considered a **plant-based diet** in that it emphasizes the consumption of vegetables, fruits, grains, legumes, and other plant foods with lower proportions of animal foods. Mediterranean diets include fish and occasional consumption of lean protein sources such as poultry, but most of overall food intake comes from plants. Most nutrition and health experts agree that Americans should be eating far more plant foods than they are—and the general public seems to know this, too. According to national surveys from organizations such as the International Food Information Council (IFIC), Americans say that eating more fruits and vegetables is among the important changes they can make to their diet and that eating fewer animal foods, particularly red meats and processed meats that are smoked, cured, or salted, would likely be advantageous, too.

VEGETARIAN AND SEMI-VEGETARIAN DIETS

A recent poll estimates that approximately 3.3% of all U.S. adults consider themselves vegetarians, with at least 6% of young adults ages 18–34 years reporting avoidance of most

or all animal foods. Worldwide, reported prevalence rates vary by country, with India topping the list with an estimated 38% of the population following a vegetarian eating style. In Israel, prevalence rates are about 13%; 12% in Taiwan; and around 9% in the United Kingdom, Germany, and Austria. All true **vegetarian** diets completely eliminate meat, poultry, fish, and shellfish. The **lacto-vegetarian** diet consists of plant foods in addition to dairy (lacto) products. **Lacto-ovo-vegetarians** consume plant foods in addition to dairy products and eggs (ovo). A **vegan** diet, representing just under half of all vegetarians, is considered the most limited type, excluding all foods of animal origin, including dairy, eggs, and honey. Individuals who restrict their consumption of some meats may refer to themselves as vegetarians, but they are more appropriately considered **semi-vegetarians**. This includes those who exclude only red meat but eat all other animal products (**quasi-vegetarians**), those whose diet excludes red meat and poultry but includes fish and shellfish (**pescatarians**), and those who eat a mostly plant-based diet but who occasionally eat meat, too (**flexitarians**). **(INFOGRAPHIC C.1)**

MEDITERRANEAN DIET

a dietary pattern traditionally followed in Mediterranean countries that has been proven to have health benefits

PLANT-BASED DIET

a diet that emphasizes whole plant foods, limits processed foods, and may or may not include foods of animal origin

VEGETARIAN

a diet consisting of plant-based foods, which excludes all meats, fish, and shellfish but may include dairy products and eggs

LACTO-OVO-VEGETARIAN

a vegetarian diet consisting of plant foods in addition to dairy (lacto) and egg (ovo) products

VEGAN

a vegetarian diet that eliminates all foods of animal origin

PESCATARIAN

a semi-vegetarian diet that excludes meats and poultry but includes plant foods, dairy foods, eggs, fish, and shellfish

INFOGRAPHIC C.1 Types of Vegetarian Diets

Vegetarians do not consume gelatin (a primary component of Jell-O) because it is a protein that has been isolated from the skin and bones of animals.

	VEGETARIANS Consume no meat, poultry, fish, shellfish, animal broths, gelatin, or lard			SEMI-VEGETARIANS Consume eggs and dairy in addition to:		
Vegetarian Diet Type	Vegan	Lacto-vegetarian	Lacto-ovo-vegetarian	Pescatarian	Quasi-vegetarian	Flexitarian
Animal Foods Eaten	None	 Dairy products	 Eggs and dairy products	 Fish	 Poultry and fish	 Limited amounts of meat, fish, and poultry



What may be the most common difference in the reasons people give for choosing to be vegetarians versus semi-vegetarians?

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PLANT-BASED DIETS

Taking the meat out of a meal doesn't necessarily improve its nutrient profile. What substitutions could make this meatless meal more nutrient-dense?



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Vegetarians not only can meet the recommended intakes for various nutrients with a little dietary planning but also can benefit from a reduced incidence of chronic disease and lower mortality rates compared with people eating a typical Western diet of high meat intake, refined grains, and ultra-processed foods. However, the decision to “go vegetarian” does not necessarily *guarantee* better health. Some vegetarians eat primarily grain-based foods or legumes without giving much attention to variety or overall nutrition, which is not necessarily the healthiest approach. The quality of the diet depends significantly on the amount and distribution of the nutrients being consumed and the types of food choices being made.

BENEFITS OF A DIET RICH IN PLANT FOODS

Although people worldwide follow plant-based diets for various reasons—cultural, ethical, environmental, and religious—there are also plenty of health reasons to do so. Studies show that vegetarians have lower total blood cholesterol, low-density lipoprotein levels, and low blood pressure, all of which reduce their cardiovascular risks; indeed, research suggests that vegetarians

have a lower risk of obesity, heart disease, hypertension, cancer, type 2 diabetes, and premature death than those who consume a typical Western diet. Vegetarians also tend to have a higher intake of certain nutrients, including vitamins C and E, magnesium, potassium, folate, antioxidants, and phytochemicals.

Affirming the nutritional and health benefits of plant-rich diets, the 2015 Dietary Guidelines for Americans include the Healthy Vegetarian Eating Pattern that provides recommendations for those who follow a vegetarian pattern. Similar to the Healthy U.S.-Style Pattern, it increases consumption of soy products, legumes, nuts and seeds, and whole grains and eliminates meats, poultry, and seafood. (Refer to Chapter 2.) To reflect the habits of most U.S. vegetarians, dairy foods and eggs are included, but a vegan variation is provided. Echoing earlier Guidelines, the 2015 edition cites reduced risk of cardiovascular disease, lower rates of obesity, and lower total mortality rates associated with vegetarian-style eating patterns.

How and why plant-based diets are beneficial is an area of active research. A plant-based diet may promote overall health, reduce chronic disease risk, and lower mortality rate because of general patterns of lower body weight, decreased consumption of processed (smoked, salted, cured) meat, and an increased consumption of plant foods. For example, a diet rich in meat may be at the expense of fruits and vegetables and the fiber and other beneficial, biologically active nutrients they contain. Some processed meats contain potentially carcinogenic (cancer-causing) compounds formed during cooking or produced during processing to preserve color or flavor. Both the American Cancer Society (ACS) and the American Institute for Cancer Research (AICR) encourage a plant-based diet as an important cancer risk reduction strategy.

HOW CANCER DEVELOPS

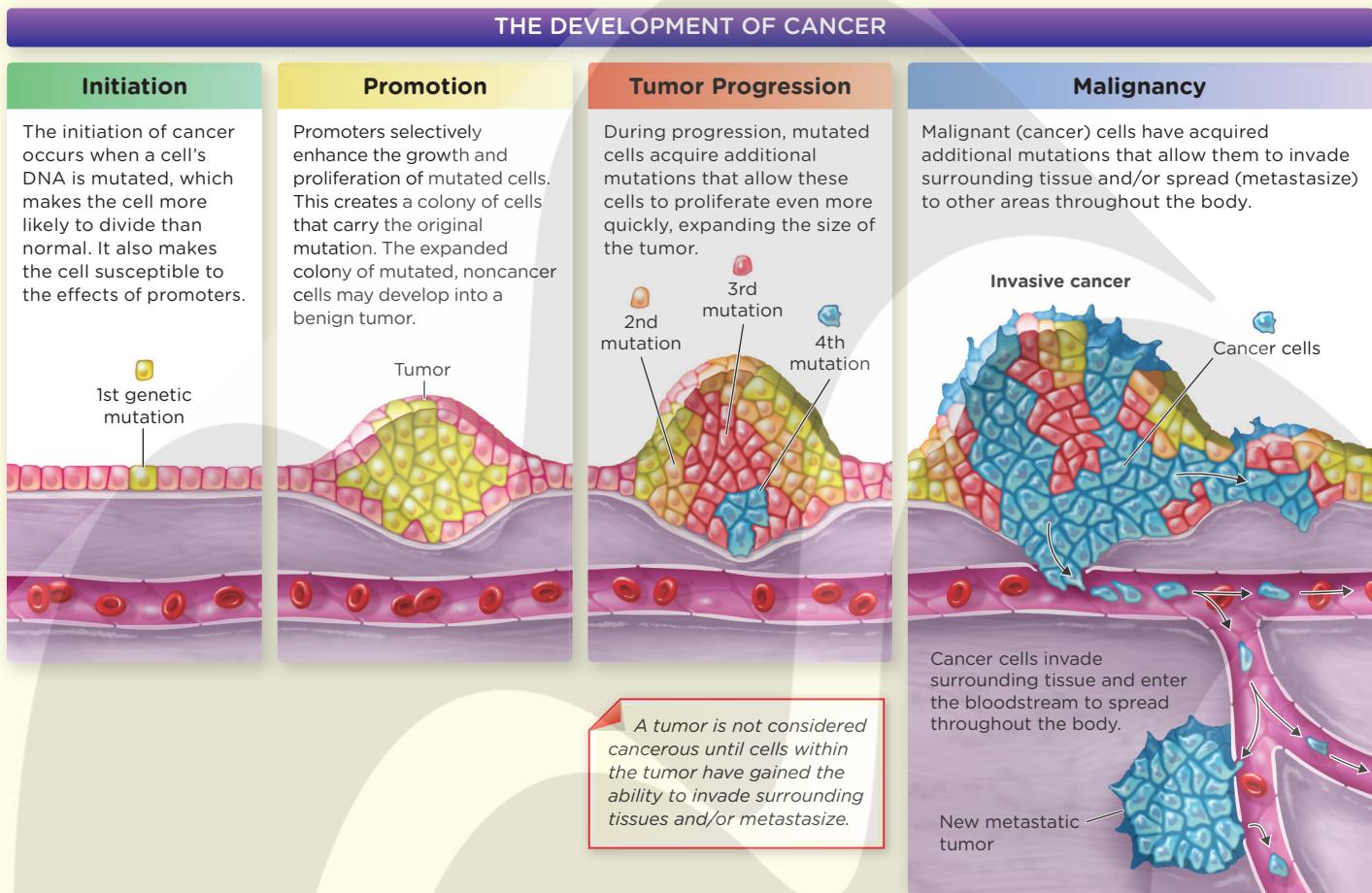
Indeed, studies demonstrate that plant-based diets reduce the risk of **cancer**, the second leading cause of death in the United States, ranking just below cardiovascular disease.

Cancer is a group of conditions that result from the uncontrolled growth or division of

CANCER

the uncontrolled growth or division of abnormal cells that invade a part or parts of the body

INFOGRAPHIC C.2 **Cancer Development Is a Multistep Process** *The stages of cancer include initiation, promotion, and progression.*



? *The development of all cancers requires what initiating event?*

abnormal cells that invade a part or parts of the body. Although scientists don't fully understand how cancer develops, there is consensus that it is a multistep process. **(INFOGRAPHIC C.2)**

First, during the process of cancer initiation, DNA inside a cell undergoes a **mutation** that alters the DNA sequence permanently. Any cells produced from the division of the mutated cell will also carry the mutation. Once a cell has been mutated, it is susceptible to the effects of promoters. During cancer *promotion*, various factors (for example, inflammation or some chemicals) selectively promote these mutated cells to divide and proliferate more quickly than they should. In the process of cancer *progression*, the mutated cells acquire additional mutations that allow the cells to

divide even more quickly and further progress to becoming **malignant cells** (cancer cells) that are able to invade other tissues and to migrate to other locations in the body (**metastasis**), where they can form new tumors that disrupt the function of body organs and tissues.

Although many cancers are influenced by genetic factors, cancer risk is also affected significantly by environmental factors, including lifestyle choices—so in that sense, dietary choices can both increase and decrease risk. For example, eating a diet rich in vegetables, fruits, and legumes has been linked with a reduced risk of mouth, esophageal, stomach, and colon cancer. In contrast, alcohol consumption is associated with an increased risk of several types of cancer. **(INFOGRAPHIC C.3)**

MUTATION

a permanent change in the DNA sequence of a gene

MALIGNANT (CANCER) CELLS

have acquired mutations that allow them to invade surrounding tissues and/or migrate to other tissues and form new tumors

METASTASIS

during the process of cancer progression, mutated cells acquire additional mutations that allow the cancer cells to migrate to and invade other tissues some distance from the original tumor

INFOGRAPHIC C.3 Recommendations to Reduce the Risk of Cancer

Achieve or Maintain a Healthy Body Weight

Increased body fat is strongly linked to an increased risk of cancers of the colon and rectum, esophagus, endometrium, pancreas, kidney, breast, and gallbladder.


Limit Consumption of Energy-Dense Foods and Avoid Sugary Drinks

Overconsumption of these foods likely contributes to weight gain and therefore cancers associated with increased body fat.


Limit Consumption of Red Meat and Avoid Processed Meat

Overconsumption of red and processed meats is strongly linked to an increased risk of colorectal cancer. Limit red meat intake to no more than 18 ounces a week.


Limit Salt Intake

Salt and salt-preserved foods are likely a cause of stomach cancer.


Encourage Infant Breastfeeding

Having been breastfed as an infant reduces the risk of children becoming overweight and obese, which are cancer risks. Mothers who breastfed their infants have a lower risk of breast cancer.


Be Physically Active

Physical activity protects against colon, endometrial, and postmenopausal breast cancer. Because physical activity also protects against weight gain, it indirectly protects against those cancers associated with obesity.


Eat Mostly Foods of Plant Origin

Most diets that protect against cancer are composed primarily of foods of plant origins. Nonstarchy vegetables and/or fruit probably protect against cancers of the mouth, esophagus, stomach, and lung. Foods containing fiber protect against colorectal cancer.


Limit Alcoholic Drinks

There is no amount of alcohol consumption that does not increase the risk of cancer. Alcohol consumption increases the risk of mouth, pharynx, larynx, esophagus, and colorectal cancers.


Aim to Meet Nutritional Needs through Diet Alone

High-dose supplements may increase the risk of some cancers. In others cases, intake of nutrients from foods is found to be protective but nutrient supplements are not.


Avoid Consuming Moldy Grains, Legumes, and Other Foods

Some molds produce aflatoxins that are potent cancer-causing compounds.

Reference: "The Second Expert Report, Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective," from the World Cancer Research Fund, and the American Institute for Cancer Research. http://www.dietandcancerreport.org/cancer_prevention_recommendations/index.php



In what area do you see the greatest need for improvement to reduce your risk of cancer?

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STAY TUNED

For more on the sources and benefits of antioxidants, see Chapter 7.

BENEFITS OF PHYTOCHEMICALS

It is widely known that a diet rich in vegetables, fruits, legumes, and whole grains reduces the risk of cancer, heart disease, and other illnesses. Plants are rich in *phytochemicals*, which are physiologically active chemical compounds that are beneficial to human health. Although

not considered essential nutrients, phytochemicals can have *antioxidant* (protect cells from damaging effects of oxidation) or *hormonelike* actions and are associated with many health benefits. Fruits, vegetables, and whole grains can contain thousands of these compounds, which give them their color,

Eat a rainbow. Plant pigments are a rich source of phytochemicals.



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aroma, and flavor. Because phytochemicals are often color-specific, similarly colored foods, such as carrots and sweet potatoes, often contain similar types of phytochemicals—hence the recommendation to “eat a rainbow” of foods to ensure the consumption of a variety of phytochemicals.

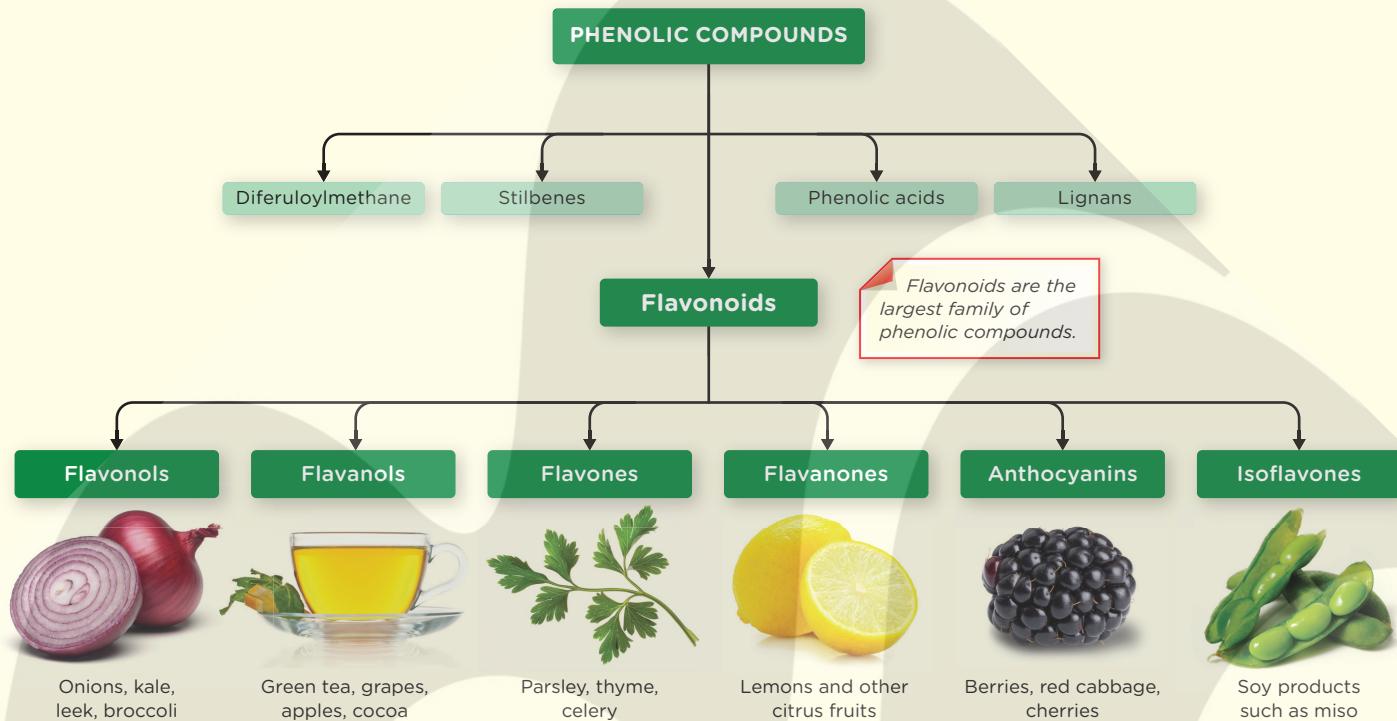
It is not yet possible to pinpoint a single phytochemical-powered bullet against cancer or cardiovascular disease, however. The sheer number of phytochemicals in plants, the complexity of the chemical processes in which they are involved, the way the chemicals

interact, and the way they are processed by the body all make it difficult to find out which phytochemicals in foods may fight cancer and other diseases, which may have no effect and may even be harmful.

Polyphenols

Although there are many types of phytochemicals, *polyphenols* are the most abundant and diverse phytochemicals in our diet. Found in a wide variety of foods, polyphenols are particularly rich in berries, coffee, tea, red wine, cocoa powder, nuts, and spices; numerous

INFOGRAPHIC C.4 **Classification of the Major Dietary Polyphenols** Polyphenols are the most abundant phytochemicals in the diet. The polyphenols called flavonoids may explain some of the health benefits associated with fruit- and vegetable-rich diets.



? What are two ways you could incorporate more flavonoids into your diet?

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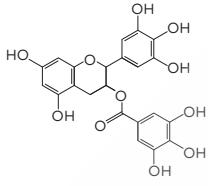
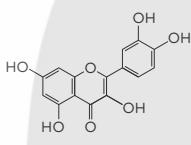
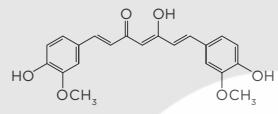
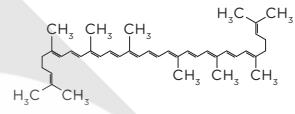
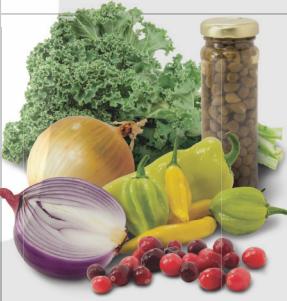
fruits and vegetables are also good sources. **(INFOGRAPHIC C.4)**

Many polyphenols have anti-inflammatory effects, and diets rich in polyphenols are associated with a reduced risk of chronic diseases such as cardiovascular disease, diabetes, osteoporosis, and neurological-related disorders. And polyphenols may reverse, suppress, or prevent the development of cancer. There are thought to be many mechanisms of action—for example, polyphenols may be able to interrupt or reverse cancer development by interrupting cellular communication systems, thus stopping the initiation or promotion of cancer. Some polyphenols can also trigger cell death (apoptosis) in cancer cells. **INFOGRAPHIC C.5** offers examples of phytochemicals, including a few polyphenols [epigallocatechin gallate (EGCG), quercetin, and curcumin], that may provide health benefits.

Resveratrol is a polyphenol found in grapes and red wine. Resveratrol has received attention because animal studies have suggested that the compound lengthens life span. Some people surmise that it might be responsible for the “French paradox,” the fact that the French, who consume many rich and high-fat foods but drink a great deal of red wine, tend to die less often of coronary heart disease than individuals from other Western countries. More research is needed as wine and other dietary sources of resveratrol may not provide the health benefits suggested or the benefits may stem from other chemical constituents.

Polyphenols are divided into several chemical classes, with flavonoids being the most abundant. Flavonoids are further divided into subclasses, including

INFOGRAPHIC C.5 Examples of Phytochemicals and Their Possible Benefits

Phytochemical	Epigallocatechin gallate (EGCG)	Quercetin	Curcumin	Lycopene
Class/Subclass	Polyphenol Flavonoid/Flavanol	Polyphenol Flavonoid/Flavanol	Polyphenol Diferuloylmethane	Carotenoid
Structure				
Excellent Sources	 White and green tea	 Red and yellow onions, hot yellow peppers, kale, capers, cranberries	 Turmeric spice	 Tomatoes, watermelon, pink grapefruit
Possible Benefits	EGCG is the most abundant flavonoid in green tea. Green tea may have anti-cancer, anti-obesity, anti-atherosclerotic, and anti-diabetic effects.	Quercetin has been shown to have anti-inflammatory effects, and it may reduce the risk of heart disease and cancer.	Curcumin may have antioxidant and anti-inflammatory effects. It may also reduce the risk of cancer and slow the progression of Alzheimer disease.	Diets high in lycopene may reduce the risk of developing cataracts and prostate and ovarian cancers.

? Which phytochemical is structurally least like the others?

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anthocyanins (abundant in berries), isoflavones (abundant in soy products and licorice), and flavanols (abundant in dark chocolate and cocoa). Some research suggests that regularly consuming moderate amounts (1 to 2 ounces a day) of dark chocolate may have beneficial effects on blood pressure, insulin resistance, and the risk of cardiovascular disease.

In addition to having antioxidant and anti-inflammatory effects, phytochemicals can also have hormonelike effects. In particular, isoflavones and lignans (both found in flaxseed), are believed to mimic the actions of the female hormone estrogen and hence belong to the subgroup of polyphenols called phytoestrogens.

Flaxseed. Phytoestrogens are abundant in flaxseed and soy foods and have chemical structures resembling those of estrogen hormones made by the body. They are being studied to better understand their effects on the body from both food and supplement sources.



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Carotenoids

Along with polyphenols, *carotenoids* are another important class of phytochemicals. (Refer to Infographic C.5.) Although more than 700 types of these pigments have been identified, only about 50 of them are common in our diet, where they are responsible for the yellow, orange, and red colors of apricots, watermelons, sweet potatoes, red peppers, and tomatoes. Some important examples of carotenoids are

beta-carotene, lycopene, lutein, and zeaxanthin. Adequate intakes of lutein and zeaxanthin (high in spinach and kale) from food sources have been shown to be important for eye health, whereas those with high intakes of dietary lycopene (in tomatoes and watermelon) have been seen to have a lower risk of prostate or ovarian cancer. Strategies to help you incorporate more phytochemical-rich foods into your diet are included in **INFOGRAPHIC C.6**.

INFOGRAPHIC C.6 Strategies to Consume More Plants (and Phytochemicals)

Use These Tips to Help Consume More Plant-Based Foods

- ✓ Plan to eat at least 5 portions of fruits and vegetables every day. Start with breakfast. Aim for 3 servings by lunchtime.
- ✓ Start your morning with fruit in plain yogurt, cereal, or sliced fruit on whole wheat toast.
- ✓ Add nuts to yogurt, cereal, or salads.
- ✓ Scramble your eggs with diced vegetables.
- ✓ Go for color. Prepare tomato-based soup and include a vegetable of every color.
- ✓ Add steamed vegetables or legumes to your favorite pasta.
- ✓ Add vegetables to pizza to increase nutritional punch.
- ✓ Drink black, green, or herbal teas.
- ✓ Add spices to your meals such as garlic, basil, oregano, sage, turmeric, thyme, or ginger.
- ✓ Keep frozen vegetables on hand to add to casseroles and soups and to stretch takeout stir fry and pasta dishes.
- ✓ Try soy products such as tofu and vegetable protein meat substitutes.
- ✓ Make your sandwiches more interesting with cabbage, carrots, cucumber, peppers, and a rainbow of lettuce colors and textures.

Frequently Consume These Phytochemical-Rich Foods



- Apples
- Apricots
- Berries
- Bok choy
- Broccoli
- Brussels sprouts
- Cabbage
- Cantaloupe
- Carrots
- Celery
- Garlic
- Green tea
- Horseradish
- Kale
- Leeks
- Lentils
- Olives
- Onions
- Pears
- Seeds
- Soy nuts
- Spinach
- Tomatoes
- Turnips

Photo credit: Eli Ensor

Nutritional Considerations and Concerns Associated with Plant-Based Diets

NUTRITIONAL CONSIDERATIONS AND CONCERNS ASSOCIATED WITH PLANT-BASED DIETS

Vegetarians must choose their foods carefully, because some nutrients are more abundant in animal foods and others are less bioavailable when consumed from plants. (INFOGRAPHIC C.7)

Protein

Vegetarians often question whether they are consuming sufficient amounts of protein. However, when vegetarians, even vegans, consume a variety of plant foods and adequate calories, they generally meet or exceed the RDA for protein. Individuals who eat fish, dairy, or eggs typically don't have to worry

INFOGRAPHIC C.7 **Make a Nutrition Plan** *Individuals who infrequently consume animal products may need a plan to obtain these important nutrients.*

Achieving adequate intakes of iron, iodine, and omega-3 fatty acids are of concern for all vegetarians. Deficiencies of calcium, vitamin D, vitamin B₁₂, and riboflavin are primarily of concern for those who follow a vegan diet.

Iron



Legumes and nuts are high in iron, but the iron is poorly absorbed. Eat these foods with a source of vitamin C (such as peppers and citrus fruits) to improve iron absorption.



Some green-leafy vegetables such as bok choy and broccoli are good sources of iron, which are also reasonably high in vitamin C.



Dried apricots and raisins are good sources of iron.



! If you take a calcium supplement, do not take it with meals rich in iron, as large doses of calcium will decrease iron absorption.

Vitamin D

If the intake of vitamin D–fortified foods and sun exposure is inadequate to meet needs, a vitamin D supplement should be taken.

Riboflavin



Mushrooms and cooked spinach are naturally good sources of riboflavin, and many breakfast cereals are fortified with high levels of riboflavin.

Vitamin B₁₂

Vitamin B₁₂ is found only in foods of animal origin and fortified plant food, including some soy and rice milks, soy-based meat analogs, and some breakfast cereals. If vegans do not consume vitamin B₁₂ regularly from fortified foods, a vitamin B₁₂ supplement must be taken.

Omega-3 Fatty Acids: EPA and DHA

Dietary supplements containing DHA from microalgae are available, as are soy milk and breakfast bars fortified with DHA. Vegetarians should include good sources of linolenic acid in their diet (flaxseed, walnuts, and soy and canola oils), which can be converted into EPA and DHA.

Iodine



Because vegetarians may be at a higher risk of iodine deficiency than nonvegetarians, when salt is used, it should be iodized.

? *What vegetable is a good source of both iron and calcium? Why is vitamin B₁₂ intake not a concern for lacto-ovo-vegetarians?*

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INFOGRAPHIC C.8 Examples of Foods That Provide Complementary Proteins



Nataliya Arzamasova/Shutterstock.com



Chris Howes/Wild Places Photography/Alamy

Rice, corn, and beans all have at least one essential amino acid that is present in a lower amount than what is needed to support protein synthesis in the body. Because the essential amino acid that is low in both corn and rice is different from the one that is low in beans, combining beans with either corn or rice provides complete protein.

? Why does the protein in corn not complement the protein in rice?

about getting enough *complete proteins*—proteins that contain all nine essential amino acids in the amounts and proportions needed to support adequate protein synthesis. Some plant foods contain all nine essential acids in the ideal proportions, such as soybeans (found in tofu, tempeh, edamame, soy milk, and other soy-based products) and quinoa, the seed of a plant related to spinach. But most plant foods provide *incomplete proteins* because they do not provide all nine amino acids in the proportions needed to synthesize body proteins adequately. As a result, vegetarians need to eat *complementary protein* foods with sufficient quantities and proportions of the essential amino acids. (INFOGRAPHIC C.8) Examples of complementary protein foods are beans and grains (such as rice) or beans and most nuts; the two foods contain different *limiting amino acids* that together provide an improved mix of the essential amino acids. (Refer to Chapter 6 for further discussion on limiting amino acids.) There is no need to eat the complementary proteins in the same meal, but they should be consumed within the same day as part of an overall balanced and varied diet.

STAY TUNED

Chapter 10 describes the sources and the functions of the trace mineral iron as well as iron deficiency.

Iron

Iron is an essential mineral that again, with a varied and calorically adequate diet, vegetarians generally consume in amounts that meet their needs. However, iron found in plant foods is in a form called *nonheme*, which is less bioavailable than the *heme* iron found in animal foods. As a result, the current recommended nonheme iron intake for vegetarians, particularly vegans, is 80% higher than the iron recommendation for nonvegetarians. The challenge of meeting these higher iron requirements, especially for women and children, increases risk for suboptimal iron status and for developing *iron deficiency anemia*. To help ensure adequate intake, it is wise to include iron-containing plant foods, including soybeans, legumes, dried fruit, and iron-fortified grains and cereals.

Other Nutrients of Concern for Vegetarians

Zinc, found in soy products, legumes, grains, and nuts, is less well-absorbed from plant foods than it is from animal foods, although vegetarians typically get enough of this mineral. Calcium, vitamin D, and riboflavin (vitamin B₂) are also considered nutrients of

concern for vegetarians. Although intake of these nutrients in lacto-ovo-vegetarians is similar to intake in nonvegetarians, vegans may fall below recommended intake levels because they avoid dairy products, which are important sources of these nutrients. Vegans can, however, obtain calcium by eating leafy greens and broccoli, and they can get both calcium and vitamin D from fortified milk alternatives such as soy, rice, and almond milks, as well as some other fortified foods and beverages such as orange juice. Riboflavin is found in significant amounts in almonds, in moderately high amounts in mushrooms and cooked spinach, and in lower amounts in whole and enriched grains, but supplementation may sometimes be warranted especially when dairy foods are eliminated.

Vitamin B₁₂ is only found in foods of animal origin, and because unfortified plant foods contain no B₁₂, vegans must be careful to obtain it from fortified foods such as soy and rice beverages, certain breakfast cereals, and meat analogs (which are meat substitutes that are often soy-based), as well as specially fortified nutritional yeasts. If vegans can't get enough B₁₂ from these sources, a daily vitamin B₁₂ supplement may be necessary. Plant-based diets can be low in the mineral iodine, especially in vegans who avoid dairy products, seafood, sea vegetables, and iodized salt. Dairy products (particularly milk) are the single largest contributor of iodine in the U.S. diet, but milk alternatives (soy and almond, for example) contain no iodine, which is vital for thyroid health. For these reasons, it is recommended that vegan women of child-bearing age supplement with 150 micrograms of iodine per day.

Finally, vegetarian diets are generally rich in omega-6 fatty acids, but they may be marginal in the omega-3 EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid), which are found primarily in fish. (Refer to Chapter 5 for more in-depth discussion of fatty acids.) Plant foods do provide the omega-3 ALA (alpha-linolenic acid), but less than 10% of ALA in plant foods is converted to EPA and DHA. Foods such as soy milk, margarine, and eggs also contain EPA and DHA. Vegetarians who avoid animal sources of DHA and EPA

Individuals following a diet free of all animal products can meet vitamin B₁₂ needs by eating fortified breakfast cereals, fortified soy milk, and fortified meat substitutes.



Susan Gottberg/Alamy

STAY TUNED

For more information on vitamin D, see Chapter 7; on riboflavin and vitamin B₁₂, see Chapter 8; on calcium, see Chapter 9; and on zinc and iodine, see Chapter 10.

can boost their intake of ALA through walnuts, flaxseeds, soy, and algae.

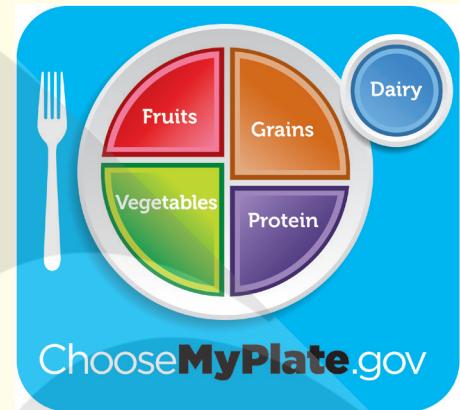
PLANT-BASED AND VEGETARIAN GUIDELINES

The Academy of Nutrition and Dietetics recommends that vegetarians choose a variety of foods, including whole grains, vegetables, fruits, legumes, nuts, seeds, and, if desired, eggs and dairy products (ideally the lower-fat varieties in moderation). It also helps for vegetarians to emphasize whole, unrefined foods and to minimize their intake of highly sweetened, fatty, and ultra-processed foods, which can be lower in nutrient content. Strict vegetarians such as vegans may need to take certain supplements or consume fortified food products to ensure that they are getting adequate amounts of every nutrient—particularly vitamin B₁₂ and vitamin D (especially if sunlight exposure is limited).

MyPlate gives guidance for building a vegetarian meal. Simply fill the protein portion of the plate with plant sources of protein, including beans, peas, lentils, soy, seeds, and nuts.



mama_mia/Shutterstock



USDA Center for Nutrition Policy & Promotion

Vegetarians who restrict all or most animal foods should consult with their healthcare provider or a registered dietitian nutritionist (RDN) to assist with their dietary planning and to get advice regarding any nutrients of concern and possible dietary supplementation. There are also many dietary planning resources for vegetarians. The USDA's www.ChooseMyPlate.org, for instance, includes useful tips for vegetarians.

Children and adolescents can be vegetarians, too, but given their higher nutrient needs to support growth and development, they may be at more risk than adults for nutrient inadequacies. Nutrients that may require consideration for adequacy in the diets of young vegetarians are similar to those in adults: iron; zinc; vitamin B₁₂; and if excluding dairy foods, calcium, iodine, and vitamin D. When adolescents are careful to consume the nutrients they need, plant-based diets can have health advantages: Research suggests that vegetarian teens consume more fiber, folate, vitamin A, and vitamin C than nonvegetarians do. They also tend to consume fewer sweets, salty snacks, and saturated fat compared with non-vegetarian teens, which can reduce the risk of obesity and chronic disease later in life.

Plant-based diets that emphasize fruits, vegetables, legumes, grains, nuts, and seeds are not only more health promoting than the typical U.S. diet but also more sustainable than diets rich in animal products. There is mounting evidence that shifting to plant-based diets with significant decreases in meat

consumption (often to less than 1 serving per week) will reduce the environmental impact of food production. For example, several studies have shown that if the population switched from a Western diet to a Mediterranean diet, we would reduce our environmental impact because greenhouse gas emissions, energy and water use, and agricultural land use would decrease.

THE MEDITERRANEAN DIET

With the plethora of media headlines reporting attributes and accolades of plant-based diets from many in the health and nutrition community, many Americans are giving plant-based diets, including the Mediterranean diet, a try. The Mediterranean diet is considered a “whole diet approach” rather than a focus on certain dietary components (for example, reducing intake of specific dietary fats); it focuses on consuming a variety of healthy whole foods. **(INFOGRAPHIC C.9)**

There is, of course, no single Mediterranean diet: At least 16 countries border the Mediterranean Sea, and diets differ in these countries and in the regions within them, just as people in California eat differently from people in Alabama. In addition, individuals in Mediterranean countries also have different cultures, ethnic backgrounds, religions, economies, and agricultures, resulting in sometimes radically different food choices. Even within communities, adherence to a traditional Mediterranean eating style differs

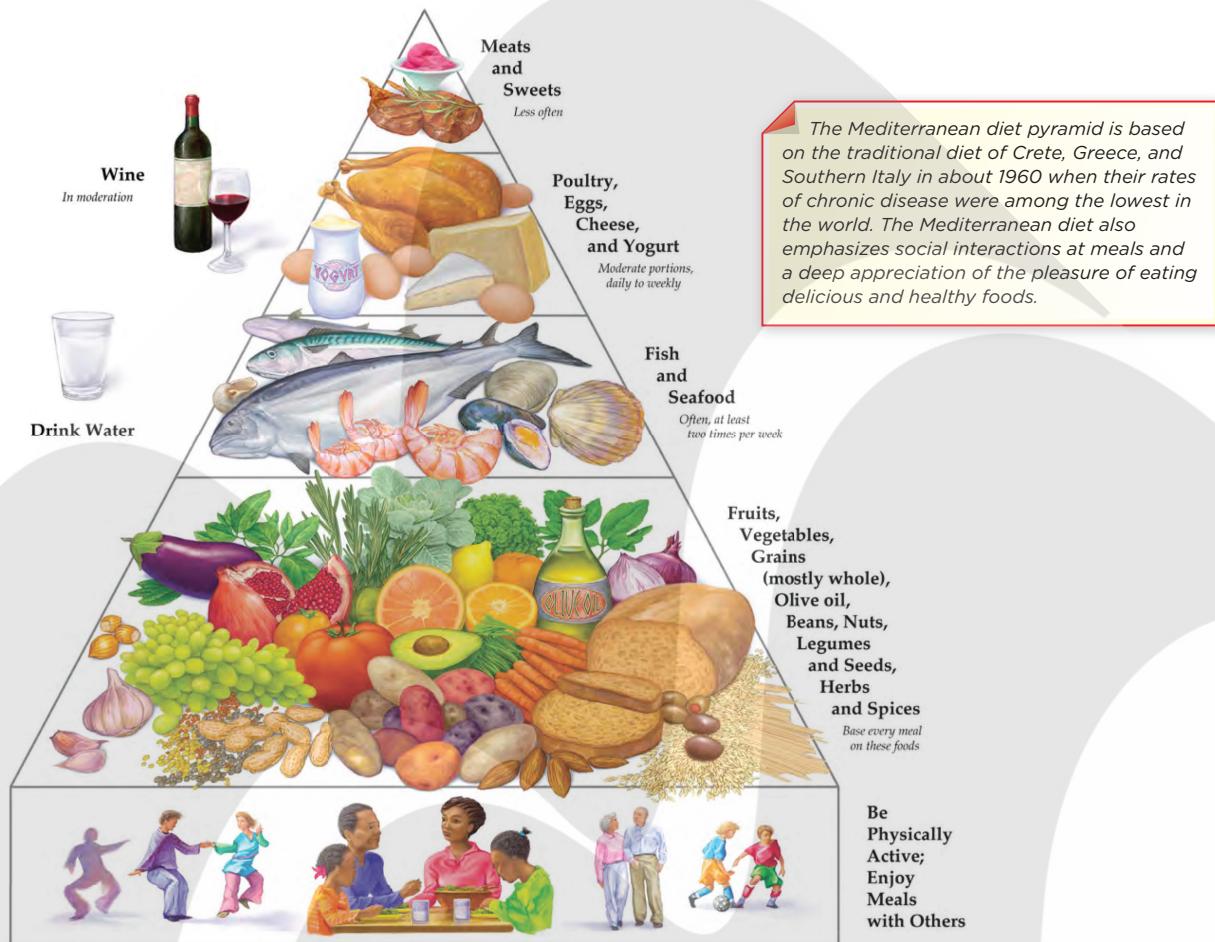
STAY TUNED

Spotlight F covers childhood nutrition.

STAY TUNED

Sustainability is discussed in more detail in Chapter 14.

INFOGRAPHIC C.9 The Mediterranean Diet Pyramid



? What category of food is eaten daily by most individuals living in the United States but is consumed only occasionally by those who adhere to a Mediterranean diet?

Photo credit: © 2009 Oldways Preservation & Exchange Trust, www.oldwayspt.org.

based on age and other lifestyle choices as well as educational and socioeconomic level.

Regardless of their differences, most Mediterranean-style diets share certain features. For instance, more than half of the fat calories in a Mediterranean diet come from monounsaturated fats (mainly from olive oil), which appears to have beneficial blood lipid and other cardioprotective effects. (Refer to Chapter 5 for details on monounsaturated fats.) In addition, the Mediterranean dietary pattern emphasizes a high intake of vegetables, legumes, fruits, nuts, whole grains, cheese or yogurt, fish, and healthy oils. Perhaps as a result of the shared features

of this diet and the associated lifestyle, the incidence of heart disease in most Mediterranean countries is lower than in the United States. Death rates are lower, too. However, it's impossible to know how much of a role diet plays and how much can be attributed to lifestyle, as people living near the Mediterranean Sea generally lead very different lives than Americans do.

In addition to its heart-healthy benefits, the Mediterranean diet is associated with a reduced number of chronic diseases, including diabetes, Parkinson's disease, allergies (in children), and cancer. The mechanism by which it reduces cancer risk may have something to do with

A Mediterranean diet includes fresh fruits, vegetables, olive oil, fish, and infrequent consumption of meat.



Sergey Yechikov/Shutterstock

the fact that the Mediterranean diet provides a healthy ratio of omega-6 to omega-3 fats and that it is high in fiber, antioxidants, and polyphenols. The diet also involves a “Mediterranean way of drinking,” which means regular, *moderate* consumption of wine, mainly with food, which has been associated with a reduced risk of chronic disease. Finally, the Mediterranean diet may also reduce the risk of Alzheimer disease and dementia, which cause cognitive decline, the deterioration of mental processes such as memory and reasoning. A 2017 systematic review of 31 studies revealed that although more research is warranted, the Mediterranean diet could play a major role in maintaining cognitive health and reducing the risk of dementia.

The 2015 Dietary Guidelines for Americans include the Healthy Mediterranean-Style Eating Pattern as an alternative to the Healthy U.S.-Style Eating Pattern (see Chapter 2). According to the guidelines, this alternative was designed “to more closely reflect eating patterns that have been associated with positive health outcomes in studies of Mediterranean-Style diets.” The Healthy

Mediterranean-Style Eating Pattern contains more fruits and seafood and less dairy than the U.S.-Style and, with the exception of calcium and vitamin D, has similar nutrient content. The guidelines state that “the healthfulness of the pattern was evaluated based on its similarity to food group intakes reported for groups with positive health outcomes in studies rather than on meeting specified nutrient standards.”

So if you want to stave off your risk of chronic disease, what diet is best? No one yet knows for sure, but current evidence strongly supports that a number of healthy plant-based diets, including Mediterranean diets, are excellent choices. Columbia University neurologist Nick Scarmeas, who led the 2009 study, admits that he’s partial to the Mediterranean diet, but that’s more because of how he was raised than anything else. “I am originally from Greece,” he says. “This is the diet my mother cooked.”



SPOTLIGHT C BRING IT HOME

Adopting a vegetarian diet

Imagine your 15-year-old daughter Sophie has decided to avoid all animal foods. You are concerned about potential nutritional inadequacies and how Sophie's diet will affect family food shopping, meals, and budget. Sophie shares that she and her closest friend decided to avoid all animal foods after watching a film on animal rights. Sophie's weight is within a healthy range, and presently she does not have any medical conditions that might affect her health or nutritional status. She is on her high school dance team and practices several afternoons a week. You ask Sophie to describe a recent day's intake of food and beverages. Based on her 24-hour recall and what you've learned about vegetarian diets, address the following questions.

Sophie's 24-hour food-intake recall:

Breakfast

1 cup oatmeal made with water
1 banana, sliced

LUNCH

1 bagel with 2 tablespoons peanut butter
1½ ounces potato chips
12 ounces soda

Snack

2 ounces pretzels
1 apple

Dinner

2 cups pasta
1 cup plain marinara sauce
3 meatless (soy-based) meatballs
2-ounce slice sourdough bread
1 tablespoon olive oil (for bread)
2 cups tossed vegetable salad
2 tablespoons Italian dressing

Snack

1 cup grape juice
¼ cup soy nuts

Consider

1. Based on Sophie's present dietary choices, what type of vegetarian diet has she decided to follow?
2. What is Sophie's primary motivator for adopting this eating style? What are other reasons individuals decide to adopt predominantly plant-based diets?
3. What are the best sources of protein in Sophie's 24-hour food-intake recall? Discuss how individuals avoiding animal foods can obtain all the essential amino acids, and provide specific examples.
4. Did Sophie consume an appropriate number of foods from each food group? Did she consume an adequate amount of calcium and fiber? Explain.
5. What modifications would you make to this day of Sophie's meals to maximize nutrient density?
6. Considering Sophie's age and life stage, should she visit a registered dietitian for further advice? Why or why not?
7. Identify at least two resources to share with Sophie to assist with dietary planning and ideas for food products and recipes.
8. Sophie expresses the hope that her parents might also consider reducing intake of animal foods in favor of a more plant-based diet. Sophie's father asks if they have to give up all animal foods to adopt a vegetarian diet and if there are actual health benefits if they do so. Discuss.

TAKE IT FURTHER

Record your own 24-hour food-intake recall. Examine your day's intake in relation to plant-based food choices. Would you consider your overall intake primarily plant-based? Why or why not? What changes might you make to boost intake of whole plant-based foods? Over the next week, plan to have at least three vegetarian (or vegan) lunches or dinners in place of meals that might contain meats, poultry, or other animal foods. What typical meals might you change, and what plant foods would you substitute for animal foods? If you already follow a vegetarian eating style, identify the sources of complete or complementary proteins in several of your meals.

KEY IDEAS

Plant-based diets can vary significantly by including differing types and amounts of animal foods, and they can have varying degrees of healthfulness depending on the quality and distribution of the nutrients being consumed and the types of food choices being made.

A vegan diet consists only of plant foods, whereas other types of vegetarian diets may include dairy foods and eggs; semi-vegetarian diets may include limited amounts of fish, poultry, and red meats.

Plant-based diets are associated with numerous health benefits. Research suggests that vegetarians have a lower risk of obesity, heart disease, hypertension, cancer, and type 2 diabetes and an overall lower risk for early mortality.

Cancer is a disease that results from the uncontrolled growth or division of abnormal cells that invade a part or parts of the body. Cancer develops in a multistep process that includes initiation, promotion, and progression. Dietary choices can both increase and decrease risk of cancer.

Recommendations to reduce risk of cancer include emphasizing foods of plant origin, maintaining a healthy body weight, limiting consumption of processed meats, and including other diet and lifestyle practices.

Phytochemicals are chemical constituents in plants that have a wide array of effects in the body and are associated with many benefits to human health.

Vegetarian diets that exclude all or most animal foods require planning to meet nutrient needs. Nutrients of potential concern include protein, iron, calcium, vitamin D, riboflavin, vitamin B₁₂, omega-3 fatty acids, and iodine.

Complementary protein foods are incomplete protein plant foods that, when consumed together or during the course of a day, provide all essential amino acids to help meet protein needs.

The traditional Mediterranean diet has unique characteristics and multiple health benefits.

NEED TO KNOW

Review Questions

- Marilyn follows a vegan diet. So which of the following foods does she avoid?
 - butter
 - coconut oil
 - maple syrup
 - peanut butter
 - white rice
- Pete is a quasi-vegetarian. So he includes all of the following in his diet, EXCEPT:
 - butter
 - eggs
 - lean beef
 - shrimp
 - turkey
- Studies examining the benefits of vegetarianism cite all of the following, EXCEPT:
 - a lower risk of cancer.
 - a lower incidence of iron-deficiency anemia.
 - a lower risk of obesity.
 - a lower incidence of high blood pressure.
 - lower rates of type 2 diabetes.
- Vegetarians who emphasize whole plant foods tend to have higher intakes of all of the following, EXCEPT:
 - dietary fiber.
 - magnesium.
 - potassium.
 - riboflavin.
 - vitamin C.
- During which stage of cancer development does the body lose control over the mutated cells, allowing metastasis to other tissues?
 - initiation
 - promotion
 - progression
 - proliferation
 - termination
- Characteristics of the polyphenols include all of the following, EXCEPT:
 - they are the most abundant and diverse category of phytochemicals.
 - they are found in salmon and other cold-water fish.
 - they are found in coffee, tea, and red wine.
 - they include flavonoids and isoflavones.
 - many have anti-inflammatory effects.
- The type of phytochemicals responsible for the yellow, orange, and red colors of fruits and vegetables are:
 - anthocyanins.
 - carotenoids.
 - isoflavones.
 - lignans.
 - resveratrol.
- All of the following are true about complementary protein foods, EXCEPT:
 - they must be consumed at the same meal or snack to support protein synthesis.
 - together they can improve overall protein quality.
 - they have different amino acids that together provide all essential amino acids.
 - an example is refried beans on a corn tortilla.
- Iron found in plant foods (nonheme iron) is lower in bioavailability than the heme iron found in animal foods. Thus, the U.S. Dietary Reference Intake of nonheme iron is _____ higher for vegetarians than the iron recommendation for nonvegetarians.
 - no
 - 20%
 - 40%
 - 60%
 - 80%
- Jason follows a vegan diet and avoids all animal foods. He consumes a wide variety of vegetables, fruits, grains, beans, and other whole plant-based foods. Despite his nutrient-rich diet, supplementation or use of foods fortified with _____ is recommended.
 - potassium
 - protein
 - extra fiber
 - vitamin B₁₂
 - vitamin K
- Recommended strategies to reduce the risk of cancer include:
 - avoiding processed meats.
 - emphasizing plant foods.
 - being physically active.
 - limiting salt intake.
 - all of the above.
- Characteristics of the traditional Mediterranean diet include all of the following, EXCEPT:
 - an avoidance of alcohol.
 - an emphasis on healthy fats.
 - limited consumption of red meat.
 - limited consumption of refined, processed foods.
 - small portions of nuts.