Nutrition: What students want to know

Video Transcript

Jessica: I was wondering if it is more beneficial to eat three solid meals a day or to eat three smaller meals and then snack in between meals.
Kaitlin: How can I make healthier choices in the cafeteria?
Paige: Is eating breakfast in the morning really more beneficial than not eating breakfast at all?
Jamee: How much is a serving when it comes to a typical meal?
Anthony: Is it true you're supposed to have eight glasses of water a day?
Linda: Fruits. Vegetables. Which is better? Fruits or vegetables?
Heather: Do I really need to eat vegetables?
Nathaniel: Why, when you actually need some fats, do people tell you continually to stay away from them?
Stephanie: I am a vegetarian, and I am probably not getting enough protein, and so I was wondering what should I do?
Nels: How much should I be eating?
Josh: Mostly for nutrition what confuses me is all of the little numbers on the back of the box. I just don't really know what to make of it. On like the nutrition value, it'll say percent of your daily value, but I just—that's for how many servings? I just feel like lots of it's misleading.
Jamee: How does sugar tie into your diet, and how much do you need, if any?
Jon: Just there's so much out there about all this stuff that you don't really know what's true, or what's the right thing.

After going through this lesson, you will be able to:

- Define essential nutrient;
- Identify the general functions of each category of essential nutrients;
- Differentiate between complete and incomplete proteins, simple and complex carbohydrates, and the various types of fat and cholesterol;
- Recall the benefits of including fiber in the diet;
- Recognize how protein, carbohydrate, and fat intakes affect health and disease risk; and
- Understand the importance of consuming a nutritionally adequate diet that includes a variety of whole foods and all of the essential nutrients.
Note: As you go through this lesson, you will come across some relatively specific and scientific information. The purpose of this is to help you understand the reasons behind the dietary recommendations. Try not to get bogged down by all of the details and scientific terms. Instead, consider the big picture of why good nutrition is important for good health. Use the objectives above as a guide for where to focus your attention.

**Food is a basic human need; we can't survive without it.**

**Nutrition** is a multi-dimensional science; it is the study of food and how food is digested—or broken down—into energy, nutrients, and other substances that are needed by the body for growth and health.

**Essential nutrients** are those that you need to get from food you eat because they are necessary for the body to survive and function properly, but your body can’t produce them, or at least not enough of them. The essential nutrients are:

- Protein
- Carbohydrate
- Fat
- Water
- Vitamins
- Minerals

Protein, carbohydrate, and fat are **macronutrients**. They are the essential nutrients that supply energy—**calories**—and therefore fuel our bodies. However, they can’t be converted to energy without proper amounts and combinations of vitamins, minerals, and water—the **micronutrients**.

**Throughout this lesson, we'll explore each of the essential nutrients—their functions and relationship to health and disease risk, their food sources, and how much of them we need to consume.**

Following extensive review and analysis of existing literature, the Food and Nutrition Board of the Institute of Medicine of the National Academies of Science, Engineering, and Medicine provided recommendations for each of the nutrients. The **recommended dietary allowance**—or RDA—for a particular nutrient is the average daily amount deemed necessary to meet the nutritional needs of practically all healthy people. When there was insufficient evidence to establish an RDA for a nutrient, the Food and Nutrition Board determined an **adequate intake**—AI—which is the level assumed to provide nutritional adequacy. Many essential nutrients also have a **tolerable upper intake level**—UL—the maximum daily amount beyond which adverse effects are likely to occur. Finally, the Food and Nutrition Board has estimated **acceptable macronutrient distribution ranges**—AMDR—for protein, carbohydrate, and fat based on evidence of adverse effects from consuming too little or too much of
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each of these nutrients. Collectively, these recommendations are referred to as the **dietary reference intakes**—or DRIs.

**Resources**
- Food and Nutrition Board
- DRI Information and Tables
- DRI Infographic

As one of the macronutrients, protein provides energy: four calories per gram. It serves several other important roles as well.

Protein is the building block for all types of body tissue, including bone, skeletal muscle, connective tissues, skin, organs, red blood cells, hemoglobin, hair, and fingernails. You might have heard that protein is important for muscle repair, and that’s true. It’s important for building, maintaining, and healing all types of tissue, including muscle.

Not only does protein provide structure for the body’s many tissues, but it’s also the basic component of enzymes and hormones. Enzymes facilitate nearly all chemical reactions in the body, and hormones coordinate many important activities; proteins are therefore involved in almost all biological processes throughout the body. For example, many enzymes are necessary for proper digestion and absorption of food. **Insulin** is the hormone that facilitates the transport of glucose from the blood into cells so that it can be used for energy. Hemoglobin is yet another example of protein’s importance; it’s essentially a transport protein that carries oxygen through the blood.

Unlike fat and carbohydrates, protein cannot be stored very long in the body. Excess protein is either converted to glucose for energy or fat for storage, or excreted in the urine. However, because so many important bodily functions require protein, it should be consumed in adequate amounts on a daily basis.
Amino acids are the building blocks of protein.

All protein molecules are made up of some combination of 20 amino acids. Nine of these are essential amino acids, meaning that they must be consumed as part of the diet. The other 11 amino acids—referred to as non-essential amino acids—can be made by the body from the essential ones. So, the human body is able to make the protein it needs if the essential amino acids are consumed in adequate amounts.

There are different types of dietary proteins.

Some are complete proteins, meaning that they provide adequate amounts of all nine of the essential amino acids. Incomplete proteins lack one or more of the essential amino acids. Animal products such as meat, eggs, and milk are examples of complete proteins. Plant proteins, on the other hand, are by and large incomplete, with the exception of soybeans, quinoa, chia seeds, amaranth, buckwheat, hemp seeds, and spirulina, which are considered complete sources of plant-based protein. They also happen to be gluten-free, which is great news for people with celiac disease or gluten sensitivity.

Incomplete proteins can be complemented, or eaten together, to make a complete protein. For example, rice and beans are both incomplete by themselves but together provide all of the essential amino acids. Hummus and pita bread is another example. Contrary to historical and popular belief, however, complementary proteins do not need to be eaten at the same time;
they can be consumed at different times, and their amino acids can still come together to form a complete protein. This is great news for vegetarians and vegans, for whom plants are the basis of their diet. They can meet the body’s protein needs if they eat a sufficient variety of protein-rich plant foods. Vegetarian diets are mostly plant-based, but typically include eggs and dairy and may also include some fish and other seafood. Vegan diets are entirely plant-based, excluding all animal products.

Even those who don’t follow a vegetarian or vegan diet on a daily basis can benefit from increasing their intake of plant-based sources of protein, such as dried beans, nuts, seeds, and whole grains.

**Resources**

- Protein Facts and Relationship to Health and Disease
- Slide Show from Health Magazine: 14 Best Vegan and Vegetarian Protein Sources

**People who don’t consume enough protein often lack other important nutrients like iron, zinc, and B vitamins.**

They can be lethargic and susceptible to infection. Fortunately, most Americans consume adequate amounts of protein to meet basic health needs.

The RDA for protein is a minimum of 56 grams (g) per day for adult males and 46 g per day for adult females or 0.8 g per kilogram (kg) of body weight per day, which is equivalent to 0.36 g per pound (lb) of body weight per day.\(^1\) However, higher amounts of protein ranging from 0.5 to 0.9 g per lb per day are appropriate and may be necessary for optimal health and functioning in some individuals, including physically active adults and athletes, aging adults, individuals needing to lose weight or maintain weight loss, and pregnant and lactating women.\(^2,3,4,5\) Protein intake at levels approximately twice the RDA has been associated with a number of benefits, including the promotion of satiety—feeling full—weight management and healthy body composition, muscle synthesis, preservation of lean body mass during weight loss and aging, functional ability with aging, and metabolic function.\(^5,6\) For physically active adults and athletes, protein promotes faster recovery, increased muscle mass and strength, and improved mental and physical performance.\(^5\)

The acceptable macronutrient distribution range for protein is 10–35% of total daily calories.\(^1\) However, some experts suggest that 15-25% may be a more appropriate and optimal range.\(^7,8\)
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There has been concern that high protein diets—which tend to be low in carbohydrates and high in fat—may cause negative side effects such as nausea, diarrhea, weak bones, kidney stones, and renal insufficiency, and be linked to obesity, osteoporosis, heart disease, and cancer risk. However, the Food and Nutrition Board concluded that there is insufficient evidence of such effects or relationships to establish a tolerable upper limit for protein. ¹

<table>
<thead>
<tr>
<th>Circumstance or Activity Level</th>
<th>Recommended Protein Intake Grams per pound of body weight per day</th>
</tr>
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<tbody>
<tr>
<td>Basic health needs</td>
<td>0.36</td>
</tr>
<tr>
<td>Recreational exercise/activity</td>
<td>0.5 - 0.7</td>
</tr>
<tr>
<td>Endurance athletics</td>
<td>0.5 - 0.8</td>
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<tr>
<td>Strength training</td>
<td>0.5 - 0.8</td>
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<tr>
<td>Weight loss/maintenance, calorie restriction</td>
<td>0.5 - 0.9*</td>
</tr>
<tr>
<td>Pregnancy</td>
<td>0.5 (or + 25 g/d)</td>
</tr>
<tr>
<td>Lactation</td>
<td>0.6 (or + 25 g/d)</td>
</tr>
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Resources

Article: How Much Protein Do You Need Every Day?
Carbohydrates are the body’s preferred source of energy. They provide four calories per gram, and it’s recommended that they make up a majority of total daily calorie intake: 45-65%.¹ There are two categories of carbohydrates: simple and complex. Simple carbohydrates are also known as simple sugars. Complex carbohydrates are made up of starch and fiber.

Simple sugars are short chains of just one or two sugar molecules, also known as mono- or disaccharides.
Monosaccharides are those consisting of just one sugar molecule, and they include glucose (blood sugar), fructose (fruit sugar), and galactose.
Disaccharides are made up of two monosaccharides: glucose plus fructose makes sucrose (table sugar), glucose plus galactose makes lactose (milk sugar), and two glucose molecules together make maltose (malt sugar).

Disaccharides are broken down into monosaccharides during digestion so that glucose, fructose, and galactose are absorbed. Fructose and galactose are
both readily converted to **glucose**, which is the only simple sugar that the body can use for energy. The body needs a constant supply of glucose for the brain, blood cells, and certain cells in the kidneys to function. When the body has more glucose than it needs, however, the excess is converted to either glycogen or fat and stored in the body. **Glycogen** consists of chains of glucose stored in the liver and muscles; it can then be broken down into glucose when the body needs it.

Sugars occur naturally in some foods, including fruits and milk. Because of their particularly sweet taste, though, they are added to many foods, such as sugar-sweetened beverages, baked goods, and candy bars. In fact, sugars are one of the most common food additives. Most of the sugar that Americans consume is sugar that’s added to products in processing or during food preparation.

**The starch and fiber that make up complex carbohydrates are found in plant foods such as grains, dried beans, fruits, and vegetables.**

**Starch** consists of long, interconnected chains of sugars. This is the part of complex carbohydrates that provides energy. **Fiber**, on the other hand, is non-digestible and therefore does not provide energy.

Fiber is classified into two types depending on its level of water solubility. Soluble fiber dissolves in water, whereas insoluble fiber does not. Both types of fiber are important. **Soluble fiber** forms a gel; it absorbs fat, cholesterol, and glucose from the intestinal tract, reducing their absorption into the bloodstream. **Insoluble fiber** adds bulk to the diet and helps people feel full without adding extra calories, potentially helping them control their overall caloric intake and their weight. It also adds bulk to the stool and helps food move through the intestines, thereby regulating bowel movements and preventing constipation. Overall, sufficient fiber intake contributes to a decreased risk of constipation, hemorrhoids, certain gastrointestinal diseases, gastroesophageal reflux disease, duodenal ulcer, diverticulitis, colon cancer, obesity, diabetes, stroke, high blood pressure, and cardiovascular disease. The recommendation for fiber is 38 g per day for adult males and 25 g per day for adult females; those over 50 years old need slightly less.
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Most whole plant foods contain some of both types of fiber, but more of one or the other. Consider an apple; the fiber contained in the pulp is soluble and the fiber contained in the skin is insoluble. Good sources of soluble fiber include dried beans and peas, lentils, oatmeal and oat bran, berries, apples, nuts, and seeds. Good sources of insoluble fiber include most whole grains like brown rice, wheat bran, and barley, as well as vegetables like carrots, cucumbers, and zucchini.

Resources
- Normal Bowel Movements
- The Scoop on Poop

Whole grains are an excellent source of complex carbohydrates. In our world of highly processed foods, though, whole grains are often turned into simpler refined versions by removing the outer two layers of the grain seed: the germ and bran. Only the endosperm, or sugary part, of the grain remains. For example, whole wheat flour becomes white flour; brown rice becomes white rice. Removal of the germ and bran strips the grain of important nutrients such as essential fats, vitamins, minerals, and fiber. To counteract this loss, some food processors add some nutrients back into processed grains by enriching them. Unfortunately, fiber is often not added back. Thus, natural whole grains provide more fiber and other nutrients than their refined counterparts do.

Resource
- Whole Grains Council
Whether you eat a simple or a complex carbohydrate, it all gets broken down into glucose and enters the bloodstream.

However, because simple sugars are small, simple molecules, they are absorbed quickly into the bloodstream and cause a sudden spike in blood glucose level. It takes longer for the body to break apart complex carbohydrates, which results in a more gradual increase in blood glucose level. Regardless of its source, the body responds to an increase in blood sugar by producing and releasing insulin from the pancreas. Insulin helps clear glucose from the blood and get it into cells so that it can be used to produce energy.

You may have heard of a condition called insulin resistance; this is when cells become less receptive to insulin and blood glucose levels remain high because the glucose can’t get into cells as efficiently. The pancreas responds to the high levels of blood glucose by producing even more insulin, in turn making the cells even less receptive to it. Unfortunately the pancreas can eventually get worn out and stop producing a sufficient amount of insulin, or stop producing it altogether. Blood glucose is then elevated not just after meals, but continuously, and this contributes to development of type 2 diabetes.

The important point to remember here is that simple sugars cause a large spike in blood glucose levels, forcing the production and release of a large amount of insulin at once. Over time, this can contribute to insulin resistance and eventually type 2 diabetes. Additionally, high sugar intake has been associated with obesity, dental caries, high LDL cholesterol and low HDL cholesterol which are
risk factors for cardiovascular disease, and colon, breast, and lung cancers. Therefore, it’s suggested that added sugars found in things like sugar-sweetened beverages, pastries, and candies be limited to less than 10% of total calories—ideally less.¹

Another downfall of simple sugars is that they don’t provide sustained energy the way that complex carbohydrates do. Although both forms of carbohydrate provide the same amount of energy, the more gradual absorption of complex carbohydrates results in a more consistent and sustained source of energy. The fiber in complex carbohydrates also helps maintain fullness for a longer period of time. Additionally, foods high in complex carbohydrates generally provide other beneficial nutrients that foods high in simple sugars don’t.

**Carbohydrates have received bad press over the years, and many people go to great lengths to outright eliminate carbohydrates from their diets.** This is a bad idea because eliminating carbohydrates means banishing an essential nutrient. Consuming little or no carbohydrate means leaving behind virtually all plant foods, depriving the body of fiber and other important nutrients.

**The body needs carbohydrates to survive and function properly.** The RDA for carbohydrate was set based on the minimum amount needed to meet just the brain’s glucose needs alone; it’s 130 g per day for adults, 175 g per day during pregnancy, and 210 g per day for lactating women.¹ For optimal full-body functioning and to account for varied energy needs, however, it’s recommended that 45-65% of total daily caloric intake come from carbohydrates.¹

The true issue is not carbohydrates themselves, but the type of carbohydrates: simple or complex. Rather than avoiding carbohydrates as a whole, it’s recommended that people minimize their intake of simple or added sugars and refined starches while maintaining adequate intake of complex carbohydrates and fiber from things like whole grains and vegetables.

Keep in mind that any form of sugar provides the same amount of calories and therefore, if consumed in excess, can contribute to weight gain.

**Resource**

[Carbohydrate Facts and Relationship to Health and Disease](#)
Like carbohydrate, fat is often demonized, and many people attempt to eliminate it from the diet.

But fat is an essential nutrient, so we need to consume it in order to survive. However, certain fats are healthier than others, and are therefore the ones we want to concentrate on eating.

**Fat is made up of fatty acids and glycerol.**
Fatty acids consist of carbon and hydrogen atoms, and each carbon molecule can have up to four bonds.

**Saturated fatty acids** only have single bonds and are saturated with hydrogen atoms, meaning no more hydrogen can be added. Saturated fats remain solid at room temperature and are mainly found in animal products, such as fatty cuts of meat, whole milk dairy products, and butter. Palm and coconut oils also are highly saturated.

**Unsaturated fatty acids** have one (mono) or more (poly) double bonds in the chain of carbon atoms and therefore fewer hydrogen atoms. Unsaturated fats are liquid at room temperature and typically found in plants, nuts, seeds, and fish. They include olive and peanut oils and vegetable oils like canola, sunflower, safflower, and corn oil.

You have probably heard of another type of fat: **trans fat**. While small amounts of naturally occurring trans fat may be present in animal products such as milk and cheese, most trans fats available in our food supply are artificially made through a process called **hydrogenation**, in which the double bond of unsaturated fats is broken and hydrogen atoms are added to make them solid.
at room temperature, in essence saturating them. Crisco is an example. Any food that contains hydrogenated or partially hydrogenated vegetable oil contains trans fats, including many crackers, cookies, and other baked goods. Food manufacturers like trans fats because they make food products more shelf-stable and can reduce manufacturing costs. However, due to mounting research about its negative health effects, pressure from consumer advocacy groups, and consumer demand, many have reduced or eliminated trans fats in their products. Further, the Food and Drug Administration has declared that partially hydrogenated oils and trans fats are no longer generally recognized as safe, prompting even more food manufacturers to discontinue their use.\textsuperscript{8,9}

**Resources**

- What Are Trans Fats?
- Tips for Cooking with Fats and Oils
There are two essential fatty acids: linoleic acid and alpha-linolenic acid. Linoleic acid is an omega-6 fatty acid. It is required for growth, maintenance of healthy skin, and normal functioning of the reproductive system. Alpha-linolenic acid is an omega-3 fatty acid. It is part of all cell walls throughout the entire body, but is found in high amounts in the brain and eyes. Both of the essential fatty acids contribute to regulation of blood pressure and blood clotting. Their consumption has been associated with a decreased risk of cardiovascular disease, cancer, and other conditions and can also help control symptoms of lupus, eczema, rheumatoid arthritis, and other chronic inflammatory conditions. The AI for linoleic acid is 17 g per day for males 19-50 years old, 12 g per day for females 19-50, and 13 g per day for pregnant and lactating women. The AI for alpha-linolenic acid is 1.6 g per day for males 19-50 years old, 1.1 g per day for females 19-50, and 1.3 g per day for pregnant and lactating women. While both essential fatty acids—omega-6 and omega-3—are good for our health, it’s recommended that we try to consume a relatively low ratio of omega-6 to omega-3 fatty acids, such as 2 or 4 to 1 as opposed to 15 or 16 to 1, which is typical of American diets. Research has shown that having a high ratio of omega-6 to omega-3 fatty acids can contribute to excessive inflammation and chronic disease, whereas a lower ratio appears to be protective against diseases like rheumatoid arthritis, cancer, cardiovascular disease, and even asthma, among others. The optimal ratio seems to vary depending on the disease in question, but regardless, the take home message is to try to consume more omega-3s and keep consumption of omega-6s in check.

The essential fatty acids are polyunsaturated. The main dietary source of omega-6 fatty acids is vegetable oils such as sunflower, safflower, corn, and soybean oils. The best source of omega-3 fatty acids is fish oils, particularly from cold water fatty fish like salmon, halibut, and tuna, because they also contain DHA and EPA. Walnuts, flaxseed, and some leafy greens are also sources of...
omega-3, and many food products are now fortified with omega-3 fatty acids, but fatty fish is still the best source.

DHA and EPA are two other omega-3 fatty acids that are particularly beneficial for heart health. While the body can produce them from alpha-linolenic acid, technically making them non-essential, their production is slow and limited and often inadequate for optimal health. Therefore, it’s important to include them in the diet.

**Resource**

List of Foods High in Omega-3 Fatty Acids

The Food and Nutrition Board did not identify a specific RDA or AI for fat, but we do know that it’s unhealthy to have too little fat in the diet.¹

Fat does more than improve the texture and taste of food. It is an essential component of the diet that provides essential fatty acids and fat-soluble vitamins. Fat also helps you feel full and provides energy. In fact, fat provides the most energy per gram of all the macronutrients: nine. That’s more than twice the amount of energy provided by protein and carbohydrate, which both provide four calories per gram.

So, you might be wondering how the body actually uses fat for energy. The glycerol component gets converted to glucose and used for energy. Excess fat beyond what’s needed for energy or other functions gets stored. Stored fat helps cushion organs against shock and regulate body temperature, but too much stored fat is a major risk factor for chronic disease such as heart disease. Thus, the recommended range for total daily fat intake is 20-35% of total calories.¹ Trans fat should be avoided, and despite debate about saturated fat, many health experts and organizations still recommend limiting its intake to less than 7-10% of total calories.¹¹,¹²,¹³,¹⁴ Instead, it’s best for most of our fat intake to come from unsaturated sources like fatty fish, nuts, seeds, and healthy oils.

**Resources**

Fat Facts and Relationship to Health and Disease
Fats & Cholesterol
Know Your Fats
Sleep, Eat & Exercise

**Cholesterol** is a waxy substance found in fat cells—or lipids—carried in the blood.

**Cholesterol** is necessary for many important body functions. It is part of every cell in the body and is a major component of the brain and nerves, and it serves as a building block for vitamin D and hormones, including estrogen and testosterone. Despite the fact that cholesterol is necessary for all of these things, it is not essential that we get it in our diets because the human body can produce it.

So, why does cholesterol get such a bad rap? Well, a primary reason is that many Americans have too much of it in their bodies, and too much of a good thing can be bad. Further, there are multiple types of cholesterol, and they have different functions.

*In the blood, cholesterol is bound to a protein carrier and referred to as a lipoprotein.*

**Low-density lipoprotein**—also known as LDL cholesterol—is considered bad; think L for lousy. It collects on blood vessel walls and can eventually lead to blockage that prevents the flow of blood to either the heart, known as a heart attack, or brain, referred to as a stroke. **High-density lipoprotein**—HDL cholesterol—on the other hand, is considered good because it is being transported to the liver for excretion from the body; think H for healthy.

Cholesterol is found only in animal products, not plant foods. Saturated fats are the primary source of dietary cholesterol, particularly from beef, high-fat milk and cheese, and egg yolks. Saturated fats raise LDL levels. Trans fats raise LDL levels even more than saturated fats do, thus contributing to an even greater risk for heart disease. However, unsaturated fats can actually help improve overall cholesterol levels—particularly monounsaturated fats, which are found in olive, canola, and peanut oils—because they increase HDL and lower LDL.

**Triglycerides** are another type of fat found in the body. They are formed when the body has excess calories that it doesn’t need, stored in fat cells as a reserve of energy, and transported in the blood via very low-density lipoprotein—or VLDL. Having a high triglyceride level increases the risk for heart disease because it contributes to hardening of the arteries or thickening of artery walls. Limiting foods high in cholesterol and saturated fat and being physically active on a regular basis can help lower and control triglyceride levels.
Now we’ll shift from our discussion of the macronutrients—protein, carbohydrates, and fat—to the micronutrients that are essential: vitamins, minerals, and water.

Micronutrients don’t provide energy in the form of calories, but are, nonetheless, extremely important for our health.

Let’s start with water.

Yes, water is an essential nutrient that must be consumed in the diet. In fact, water accounts for about 60-70% of a typical adult’s body weight. Drinking adequate water on a daily basis is important for healthy normal functioning, and you couldn’t survive for long without it. Water helps regulate body temperature, transports nutrients and waste products throughout the body, participates in energy formation, and provides a medium for chemical reactions in the body. If you have a headache or feel tired, consider your thirst; you may just need to drink more water.

Plain water isn’t the only source of water in the diet. It can be consumed via other beverages, such as milk or juice, and even foods. For example, lettuce, melon, broccoli, and many other fruits and vegetables are mostly water. It’s estimated that about 20% of most people’s fluid intake comes from food and 80% comes from beverages.

Despite popular belief, there is no official scientifically based recommendation to drink eight glasses—or 64 U.S. fluid ounces (fl oz)—of water per day.

Fluid needs vary somewhat person to person, depending on activity level, exposure to heat, and medical condition, for example, but the AI is 91 fl oz—for females over the age of 18 and 125 fl oz—for males over the age of 18. The recommendation is slightly lower for 14-18 year olds and higher for pregnant and lactating women. Keep in mind that this recommendation is for total fluid intake from beverages and foods—not just water. If about 80% of most people’s fluid intake comes from beverages, then that equates to about nine cups for women and 12.5 cups for men. But, according to the Institute of Medicine, it’s generally OK to just let your thirst be your guide. If you feel thirsty, then drink some water. Note that feeling hungry can also be a sign of thirst.

One way to gauge whether or not you’re drinking enough water is to check the color of your urine: if it’s relatively clear or light in color, then you’re probably sufficiently hydrated; if it’s dark and has a strong smell, then that’s a sign that you should probably be drinking more fluids. Further, consider how often you
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urinate: if it’s infrequent, that could also be a sign of inadequate fluid intake. According to the Bladder and Bowel Foundation, most healthy people urinate about six to seven times per 24 hours, but anywhere from four to 10 times can be considered normal.\(^ {18}\)

Note that, while water is an essential nutrient and it’s important to get enough of it, drinking too much can lead to negative consequences.\(^ {15}\) Yes, it is possible to drink too much water. Excess water can dilute the electrolytes in our bodies—such as sodium, potassium, and calcium—to dangerous levels.\(^ {19}\) An appropriate balance of electrolytes is essential for normal function of our cells and our organs. Hyponatremia—also referred to as water intoxication—is a potentially fatal condition caused by an imbalance of water and sodium in the body.\(^ {20}\) Signs of hyponatremia include lightheadedness, dizziness, nausea, and puffiness. It’s recommended that athletes drink only when they’re thirsty to avoid overhydration and exercise-associated hyponatremia.\(^ {21}\)

**Resources**
A Sample Beverage Plan

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Minerals are naturally occurring inorganic solids.

There are many minerals—think of the periodic table—but only about 15 of them are essential and therefore must be consumed in our diets:\(^ {22}\)

- Calcium
- Phosphorus
- Magnesium
- Sodium
- Potassium

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Nutrition Fundamentals 18
Essential minerals play important roles in nerve reactions and muscle contractions, and some serve as cofactors—or sparks—for important enzymatic reactions.

For example, magnesium activates enzymes involved in the formation of energy and proteins. Minerals are also important structural components of bones, teeth, cartilage, and other tissues. Further, they help maintain an adequate amount of water in the body and neutralize body fluids if they become too basic or acidic.

There are two categories of essential minerals: macrominerals and trace minerals. Macrominerals such as calcium, magnesium, and potassium, are needed in significant amounts in order for the body to function properly. Trace minerals such as iron and zinc are needed in only small amounts, but are essential nonetheless.

Resources
Table of Recommended Dietary Allowances and Upper Limits for Common Nutrients
Micronutrient Information Center

The following pages outline specific functions and sources of several essential minerals that are commonly underconsumed by Americans: calcium, potassium, magnesium, and iron. Additionally noted is their recommended dietary allowance—or RDA—which is the average daily intake level that meets the nutritional needs of practically all healthy people while decreasing the risk of certain chronic diseases. Adequate intake—AI—is a provisional RDA developed when there is insufficient evidence to support a specific level of intake. The RDA or AI represents the amount needed to prevent nutritional deficiency. Some people may need more than the RDA or AI to treat certain conditions or reach optimal health and function. It’s important to note, though, that many essential nutrients also have a tolerable upper intake level—UL—which is the maximum daily amount beyond which serious side effects could occur.
Nutrition Fundamentals

Sleep, Eat & Exercise

Note that much of the information throughout the following pages has been summarized from comprehensive factsheets compiled by the National Institutes of Health Office of Dietary Supplements. You may wish to refer to the factsheets—linked in the resources tab on each page—for more information.

Resources
Micronutrient Information Center
NIH Office of Dietary Supplements

Iron is needed for energy formation and is a component of myoglobin, which is a muscle protein.

Iron is also a component of hemoglobin and is therefore necessary for the transport of oxygen. Iron deficiency leads to weakness and fatigue, reduced attention span, poor resistance to infection, pale appearance, and developmental delays.

Iron deficiency anemia is the most common nutritional deficiency in the world. Pregnant women, infants and young children, frequent blood donors, and people with cancer, heart failure, or gastrointestinal disorders such as celiac or Chron’s disease are most likely to be at risk of iron deficiency. The RDA for males over the age of 18 and females over 50 is 8 milligrams (mg) per day; it’s 18 mg for females 19-50 years old, 15 mg for females aged 14-18 years, and 11 mg for 14-18 year old males. Pregnant women need 27 mg per day. Vegetarians and vegans should note that their RDA for iron is 1.8 times higher than the standard RDA. Some good sources of iron include:

- oysters, clams, mussels, and mollusks
- beef and chicken liver
- beef, pork, and dark poultry meat
- canned sardines
- halibut, salmon, tuna, haddock, and perch
- iron-fortified cereals
- white beans
- lentils
- tofu
- pumpkin, sesame, and squash seeds
- beets

Animal sources provide both heme and nonheme forms of iron, whereas plant-based sources provide only nonheme iron, hence the higher RDA for vegetarians and vegans. Heme iron is more easily absorbed and is less likely to
be affected by other dietary factors that can negatively impact iron absorption. Coffee and tea decrease iron absorption, as does calcium. This probably isn’t a problem for people who have enough stored iron, but for those who are deficient or may be at risk for deficiency, it’s recommended to separate the intake of iron from calcium, coffee, and tea. Soy may also hinder iron absorption. However, consuming sources of iron along with Vitamin C, meat, poultry, seafood, or alcohol increases iron absorption, as does cooking with iron or stainless steel pans.

Considering that iron deficiency is the most common nutritional deficiency, iron overdose is rare, but it can happen. The UL of iron intake for adults is 45 mg per day. Consuming more than this can contribute to atherosclerosis—buildup of plaque in the arteries—liver and heart damage, diabetes, vomiting, abdominal pain, and decreased absorption of zinc.

**Resources**
- Iron Facts from the NIH Office of Dietary Supplements
- Iron Facts from the Micronutrient Information Center

**You may already know that calcium is important for bone health, but did you know that it’s also needed for blood clotting and muscle and nerve activity?**

Calcium deficiency can lead to muscle spasms, stunted growth, weak bones, and osteoporosis, among other things. Unfortunately, many Americans—male and female—consume inadequate calcium, and more than half of adults in the United States are affected by osteoporosis or low bone mass. Postmenopausal females, amenorrheic females, individuals who are lactose intolerant or have a cow’s milk allergy, vegetarians, and vegans are at a higher risk for calcium deficiency.

Adults between 19 and 50 years of age need 1000 mg of calcium per day; the RDA for 14-18 year olds is 1300 mg. Milk and other dairy products like cheese and yogurt are excellent sources of calcium. Broccoli and dried beans have calcium, too. Many other foods are fortified with calcium, including some juices, breakfast cereals, and breads.

Keep in mind: the body can absorb up to only 500 mg of calcium at a time, so it’s best to consume small servings of calcium-rich foods throughout the day as opposed to a large amount all at once. If you take a calcium supplement, look at the label. If the pill contains 1000 mg of calcium, break it in half and take part of it in the morning and part of it in the evening. Also, the calcium in some
foods is not absorbed very well. For example, although spinach and collard greens contain calcium, it’s poorly absorbed because it’s bound to oxalic acid—found naturally in some plants—and therefore the body can’t really benefit from it.

Finally, note that the UL for calcium among 19-50 year olds is 2500 mg per day. Consuming this much or more can lead to constipation, decreased absorption of iron and zinc, and potentially kidney stones or other health risks.33

**Resources**
- Calcium Facts from the NIH Office of Dietary Supplements
- Calcium Facts from the Micronutrient Information Center
- Definition of postmenopausal
- Definition of amenorrheic

**Potassium plays a role in communication between nerves and muscles, transfer of nutrients into and waste products out of cells, and control of blood pressure.**

Symptoms of low potassium may include weakness, muscle cramping, abdominal cramping, nausea, vomiting, constipation, irregular heartbeat, fainting, severe thirst, frequent urination, mental confusion, or depression.34 Populations at particular risk for low potassium levels include people with alcohol dependence, AIDS, and eating disorders such as anorexia and bulimia, as well as those who’ve had bariatric surgery.34 The AI for potassium is 4700 mg per day for adults.15 This level of intake should help lower blood pressure, blunt the adverse effects of sodium on blood pressure, reduce the risk of kidney stones, and potentially reduce bone loss.15

Vegetables high in potassium include potatoes, sweet potatoes, winter squash, spinach, beet greens, and tomato products. White beans, lima beans, soybeans, kidney beans, split peas, and lentils are also good sources. Fruits high in potassium include bananas, prunes and prune juice, cantaloupe, honeydew melon, dried peaches and apricots, orange juice, and plantains. Other good sources of potassium include milk and milk products, meats, and coffee.

There is no specified upper limit for potassium, and getting too much of it seems to be rare. However, acute intoxication—also known as hyperkalemia—is possible and can cause death by cardiac arrest. It would take approximately 18 g of potassium to cause this in an adult.35
Magnesium is involved in the synthesis of protein, bone, and DNA and helps regulate muscle and nerve function, blood glucose levels, blood pressure, and heart rhythm. Magnesium deficiency may play a role in hypertension and cardiovascular disease, type 2 diabetes, osteoporosis, and migraine headaches. Populations at risk for magnesium deficiency include people with type 2 diabetes, chronic alcohol dependence, and gastrointestinal disorders such as Chron’s disease and celiac disease, as well as older adults.36

Fortunately magnesium is provided by a wide variety of foods, including leafy green vegetables such as spinach, legumes, nuts, seeds, and whole grains. However, the body actually absorbs only about 30-40% of magnesium consumed.36

The RDA for magnesium is 410 mg for 14-18 year old males, 400 mg for 19-30 year old males, and 420 mg for males over 30.36 It’s lower for females: 360 mg for those 14-18 years old, 310 mg for those 19-30 years old, and 320 for those over 30; pregnant women need slightly more.36

There is no upper limit for magnesium from food sources because the kidneys can excrete excess magnesium in the urine. However, there is an established UL for magnesium taken in the form of a dietary supplement: 350 mg for healthy adolescents and adults.36 Excessive magnesium intake from supplements or medications—such as magnesium-containing antacids—can cause diarrhea, which may be accompanied by abdominal cramping and nausea. Toxicity is possible at very high doses, particularly in individuals with impaired kidney function, and can be fatal.36

Resources
- Magnesium Facts from the NIH Office of Dietary Supplements
- Magnesium Facts from the Micronutrient Information Center
Zinc is a component of insulin and many enzymes and is involved in the reproduction of proteins. Not getting enough zinc in the diet can lead to slow wound healing, loss of taste and appetite, and delayed sexual maturation, among other things. The use of a zinc lozenge or syrup containing zinc may help reduce symptoms and duration of the common cold, but research on the effectiveness of this is mixed.\textsuperscript{37}

The RDA for zinc is 11 mg for males, nine mg for females 14-18 years old, and eight mg for females over the age of 19, although women who are pregnant or lactating need more.\textsuperscript{38} Zinc is present in all meats as well as milk and other dairy products, grains, nuts, ready-to-eat cereals, and bread. Zinc from meat sources is absorbed much better than zinc from plant sources because the phytates also found in grains inhibit zinc absorption; for this reason, vegetarians and vegans may need to consume more than the RDA in order to get enough.\textsuperscript{37} Other populations at risk for deficiency include pregnant and lactating women, alcoholics, and those who have gastrointestinal surgery; digestive disorders such as Chron’s disease, ulcerative colitis and short bowel syndrome; chronic diarrhea; and chronic liver disease, kidney disease, diabetes, or other chronic illnesses.\textsuperscript{37}

The UL for zinc is 34 mg for individuals 14-18 years of age and 40 mg for those 19 and older.\textsuperscript{38} Consuming more than this can lead to nausea, vomiting, abdominal cramps, diarrhea, loss of appetite, and headaches. Some of the other potential effects include decreased immune function, altered iron function, and reduced levels of high-density lipoproteins—the good cholesterol.\textsuperscript{37}

\textbf{Resources}
\begin{itemize}
\item Zinc Facts from the NIH Office of Dietary Supplements
\item Zinc Facts from the Micronutrient Information Center
\end{itemize}

Vitamins are organic compounds that, like minerals, perform specific and important functions in the body.
Many **vitamins** act as coenzymes, meaning they activate specific enzymes that affect the rates of chemical reactions in the body. For example, certain vitamins contribute to the conversion of carbohydrate, protein, and fat into energy, and some vitamins are antioxidants, which means they prevent or repair cell damage.

**All vitamins are essential.**

Some—vitamin C and the B vitamins—are water-soluble—whereas vitamins A, D, E, and K are fat-soluble. Only small amounts of the water-soluble vitamins, with the exception of vitamin B12, can be stored in the body. Thus, symptoms of water-soluble vitamin deficiencies develop quickly. Fat-soluble vitamins, on the other hand, can be stored in body fat, the liver, and other parts of the body, so it takes longer for deficiencies of fat-soluble vitamins to develop and become evident, but their potential for toxicity is also greater.

If an essential vitamin isn’t consumed adequately in the diet, its deficiency will lead to diseases specific to the functions that the vitamin played. Similar to minerals, there are RDAs or AIs and ULs for vitamins. Also, vitamins are commonly measured in terms of their **International Unit**—or IU—which is an internationally accepted amount of a particular substance based on its potency and biological activity, rather than quantity. Let’s explore the important functions of several vitamins that are commonly underconsumed by Americans: vitamins A, C, D, and E, and folate, which is one of the B vitamins.

**Resources**

- Vitamin Overview
- Micronutrient Information Center

**Sufficient vitamin D**—one of the fat-soluble vitamins—is required for proper absorption of calcium and phosphorus and their utilization in bone formation and nerve and muscle activity. Vitamin D also aids in the modulation of cell growth, immune function, and reduction of inflammation, and may play a role in the prevention of diabetes, hypertension, glucose intolerance, certain types of cancer, and other conditions, though more research is needed in these areas. Vitamin D
deficiency is associated with weak, deformed bones in children—a disease known as rickets. In adults, vitamin D deficiency can lead to the loss of calcium from bones and eventually osteoporosis. Populations at particular risk for vitamin D deficiency include breastfed infants, older adults, people with limited sun exposure, people with dark skin, people with inflammatory bowel disease or other conditions causing fat malabsorption, and people who are obese or have undergone gastric bypass surgery.

Vitamin D can be synthesized from cholesterol in cells beneath the surface of the skin upon exposure to sunlight—hence, one more reason to spend some time outside everyday! Unfortunately, sunscreens with sun protecting factor—or SPF—of 8 or higher prevent vitamin D absorption and production. However, it’s still recommended to use sunscreen whenever exposed to the sun in order to protect the skin from the sun’s harmful ultraviolet rays, as exposure to them is the primary cause of skin cancer.

**Vitamin D is naturally present in very few foods.** The best sources are fatty fish such as salmon, tuna, and mackerel and fish liver oils. Vitamin D is present in smaller amounts in beef liver, cheese, egg yolks, and mushrooms. The primary source of vitamin D in most Americans’ diets is milk fortified with vitamin D. Other food products that are sometimes fortified with vitamin D include cereal, orange juice, and yogurt.

The RDA for vitamin D is 15 micrograms (mcg), which is equivalent to 600 IUs. However, health experts continue to research and debate the optimal level of vitamin D intake, some suggesting that as much as 1000-2000 IUs per day is appropriate for adults.

Getting too much vitamin D is rare, but it is possible with excessive supplementation. Vitamin D toxicity can lead to abnormally high blood calcium levels and deposition of calcium in organs such as the kidneys, liver, and heart, which can contribute to nausea, constipation, irritability, weight loss, abnormal bone growth and formation, abnormal heart rhythm, and kidney stones. The current UL for individuals 9 years of age and older is 4000 IU per day, though some health experts argue that it’s safe for healthy adults to have a higher intake.

**Resources**
- [Vitamin D Facts from the Office of Dietary Supplements](#)
- [Vitamin D Facts from the Micronutrient Information Center](#)
Vitamin E is a fat-soluble vitamin and antioxidant—a substance that inhibits oxidation or reactions promoted by oxygen, peroxides, or free radicals.\(^4\)\(^1\)

Free radicals are molecules that contain unshared electrons, which are highly energetic and react rapidly with oxygen to form reactive oxygen species, causing damage to cell membranes in blood cells, lungs, and other tissues.\(^4\)\(^2\)

Antioxidants, like vitamin E, prevent this damage by preventing the production of these reactive oxygen species. Vitamin E inhibits the formation of plaque in arteries, has anti-inflammatory properties, and supports immune function. It may reduce the risk of eye disorders such as macular degeneration and cataracts, certain types of cancer, and cardiovascular disease, and help slow cognitive decline, but further research is needed in these areas before definitive conclusions can be drawn.\(^4\)\(^2\)

Vitamin E deficiency can lead to weakness, muscle loss, nerve damage, decreased motor control, vision loss, and impaired immune response. People with digestive and fat-malabsorption disorders such as Chron’s disease, cystic fibrosis, and abetalipoproteinemia are at greatest risk for deficiency.\(^4\)\(^2\)

There are multiple forms of vitamin E, but only one of them—alpha-tocopherol—meets human requirements. The RDA of alpha-tocopherol is 15 mg (22.4 IU) for both males and females over the age of 13, and 19 mg for lactating women.\(^4\)\(^2\),\(^4\)\(^3\). Nuts, seeds, and vegetable oils are the best sources of alpha-tocopherol. Other sources include leafy green vegetables, avocado, red pepper, asparagus, and fortified cereals. The natural form of alpha-tocopherol
(d-alpha-tocopherol) is absorbed better than the synthetic form (dl-alpha-tocopherol) that’s often used in fortification and dietary supplements.\textsuperscript{42}

Research hasn’t shown any adverse effects related to consumption of vitamin E from food.\textsuperscript{42, 43} However, excessive intake from supplements has been linked with an increased risk of hemorrhage and may also increase the risk of prostate cancer.\textsuperscript{42, 43} The official UL of vitamin E is 800 mg (1200 IU) for individuals 14-18 years of age and 1000 mg (1500 IU) for those 19 and older, though some research indicates there may be an increased risk of death from all causes at doses as low as 400 IU per day.\textsuperscript{42, 43}

**Resources**

Vitamin E Facts from the NIH Office of Dietary Supplements

Vitamin E Facts from the Micronutrient Information Center

**Vitamin A refers to a group of fat-soluble retinoids.**

Vitamin A is critical for vision and is also involved in immune function, reproduction, cellular communication, and cellular growth, playing an important role in the formation and maintenance of the heart, lungs, kidneys, and other organs.\textsuperscript{44} Vitamin A supplementation has been shown to be beneficial for people who have or are developing age-related macular degeneration—a major cause of vision loss in older people—and children who have measles.\textsuperscript{44}

Populations at risk for vitamin A deficiency include premature infants; people with cystic fibrosis; and infants, young children, and pregnant and lactating women in developing countries.\textsuperscript{44} Deficiency among preterm infants is linked to increased risk of eye, lung, and gastrointestinal diseases; dry eye due to the inability to produce tears is a common symptom of deficiency among infants, children, and pregnant women.\textsuperscript{44} Vitamin A deficiency among pregnant and lactating women is also associated with increased maternal and infant morbidity and mortality, increased risk of anemia, and slower infant growth and development.\textsuperscript{44}

The recommended dietary allowance for vitamin A is presented in mcg of **retinol activity equivalents**—or RAE—which is a standard measure of the content and activity of the various forms of vitamin A found in foods that are then converted to the active and biologically beneficial form of vitamin A—retinol—in the body.\textsuperscript{44} There are two dietary forms of vitamin A: preformed vitamin A, which comes from animal sources, and provitamin A carotenoids, which come from plant sources. The carotenoids beta-carotene, alpha-carotene, and betacryptoxanthin are converted to retinol; however, other carotenoids such as lycopene, lutein, and zeaxanthin, are not converted into vitamin A.
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**Good food sources of vitamin A include beef liver, fatty fish, dairy products, eggs, leafy green vegetables, broccoli, and orange and yellow fruits and vegetables such as bell peppers, carrots, pumpkin, squash, cantaloupe, apricots, and mango.**

Males who are 14 years old and older need a daily average of at least 900 mcg RAE; females 14 and older need at least 700 mcg RAE, with higher amounts needed during pregnancy and lactation. 43,44

Upper limits for vitamin A have been established for preformed vitamin A from animal sources and supplements. The UL is 2800 mcg RAE for individuals 14-18 years of age and 3000 mcg RAE for those 19 and older. 43,44 Chronic intake above the UL has been associated with intracranial pressure, headaches, dizziness, nausea, skin irritation, pain in joints and bones, reduced bone mineral density, increased fracture risk, coma, and even death; women who are pregnant should not take high doses of vitamin A supplements, as intake above the upper limit can cause congenital birth defects. 44

While upper limits for beta-carotene and other carotenoids have not been established, the general population is advised against taking high-dose beta-carotene supplements due to their association with an increased risk of lung cancer and cardiovascular disease in some studies. 44

**Resources**
- Vitamin A Facts from the NIH Office of Dietary Supplements
- Vitamin A Facts from the Micronutrient Information Center

**Vitamin C, also known as L-ascorbic acid, is a water-soluble vitamin needed for the synthesis of L-carnitine, certain neurotransmitters, and collagen.**

It helps the body repair wounds and fight infections. It is an antioxidant and thereby may play a role in the prevention of certain cancers, cardiovascular disease, and other diseases caused or exacerbated by oxidative stress, although the research in these areas is still inconclusive. Further, vitamin C helps the body absorb iron—one of the essential minerals.
Vitamin C deficiency can cause scurvy, a potentially fatal disease. It weakens blood vessels, cartilage, and other tissues containing collagen and therefore can lead to bleeding and bruising more easily than normal. It also contributes to fatigue, depression, poor wound healing, and slow recovery from infections. Iron deficiency anemia may also occur secondary to vitamin C deficiency. Populations most at risk for vitamin C deficiency include people who smoke and people who are regularly exposed to second hand smoke; people with certain medical conditions that cause malabsorption, such as end-stage renal disease; infants fed evaporated milk or boiled cow’s milk; and people who consume a diet that’s limited in its variety of foods.

The RDA for vitamin C is 65 mg for females 14-18 years of age, 75 mg for females over 18 and males who are 14-18 years old, and 90 mg for males over the age of 18. Pregnant and lactating women need slightly more. It’s also recommended that people who smoke get 35 mg per day more than the standard RDA because of the added oxidative stress this places on the body and because studies have consistently shown smokers to have lower levels of vitamin C in their blood.

Good sources of vitamin C include many fruits and vegetables, such as oranges and other citrus fruits, kiwifruit, strawberries, raspberries, pineapple, cantaloupe, papaya, mango, guava, avocado, broccoli, bell peppers, collard greens, Brussels sprouts, cabbage, cauliflower, tomatoes, and asparagus, as well as ready-to-eat cereals. Consuming more of these foods or taking a vitamin C supplement may help decrease the duration and symptom severity of the common cold, if taken before the onset of symptoms. Further, consuming foods high in vitamin C with your meals will help increase your body’s absorption of iron from other foods within the meal.

The UL for vitamin C intake from food and supplements is 1800 mg per day for individuals 14-18 years old and 2000 mg for those 19 and older; intake above this can cause nausea, cramps, diarrhea, and other gastrointestinal disturbances.
Nutrition Fundamentals

There are eight B vitamins:

- Folate (folic acid)
- Thiamin (vitamin B₁)
- Riboflavin (vitamin B₂)
- Niacin (vitamin B₃)
- Pantothenic acid (vitamin B₅)
- Vitamin B₆ (pyridoxine)
- Biotin (vitamin B₇)
- Vitamin B₁₂ (cyanocobalamin)

All of the B vitamins are water-soluble. They serve a wide variety of functions, but are primarily involved in the capture and use of energy from dietary macronutrients. They are necessary for reactions that build proteins and protein tissues and help promote growth and tissue repair. They are needed for normal red blood cell development and help maintain nerve tissues. B vitamins aid in cell division, promote normal functioning of the nervous system, and support normal appetite and vision. Fatigue is a common result of B vitamin deficiency, but deficiency of individual B vitamins can lead to a variety of consequences.

Adequate intake of folate—or folic acid—is particularly important for women of childbearing age, as deficiency during pregnancy is associated with increased risk of neural tube defects, low birth weight, preterm delivery, and fetal growth retardation.⁴³ That’s why it’s often recommended that all women capable of reproduction take a supplement with 400 mcg of folic acid in addition to getting folate from a varied diet.⁴³,⁴⁵ Fortunately, folate is available from a wide variety of foods, including liver, yeast, asparagus, Brussels sprouts, dark leafy green vegetables such as spinach, fruits and fruit juices, nuts, beans, peas, dairy products, poultry and meat, eggs, seafood, and fortified grains. The recommended dietary allowance for folate is presented in micrograms of dietary folate equivalents—or DFEs—a standard measure that reflects the higher bioavailability of folic acid found in fortified foods and supplements compared to natural folate from foods.⁴³ The RDA for folate is 400 mcg DFE for males and females over the age of 13, 500 mcg DFE for lactating women, and 600 mcg DFE for pregnant women.⁴³ In addition to women of childbearing age and pregnant women, individuals who are chronically dependent on alcohol and those who have malabsorptive disorders such as celiac disease, inflammatory bowel disease, and gastritis are at increased risk of deficiency. There is an
established UL for folate; it’s 800 mcg per day for individuals 14-18 years of age and 1000 mcg for those 19 and older.43

More specific information about the other B vitamins can be found via the resource links below.

Finally, though the research is inconclusive, it’s worth noting that taking oral contraceptives may interfere with the body’s ability to absorb some B vitamins, particularly vitamin B6, so a supplement may be appropriate for women who use them.45 If you take an oral contraceptive, you may want to discuss this with your healthcare provider.

**Resources**
- Oregon State University's Linus Pauling Institute Micronutrient Information Center
- National Institutes of Health Office of Dietary Supplements Fact Sheet

**Choline is not traditionally considered a vitamin, but it is an essential water-soluble micronutrient similar to the B-vitamins.**

It’s required to make certain phospholipids that are essential components of all cell membranes, and it’s involved in the regulation of several metabolic pathways.46 Choline plays an important role in fetal brain and memory development and, like folic acid, decreases the risk of neural tube defects when consumed adequately during pregnancy. Studies have also shown that individuals with higher choline intake have lower inflammatory markers that are linked to cardiovascular disease risk and lower cancer risk, as well. Further, choline deficiency is associated with fatty liver disease, atherosclerosis, and muscle damage.46

While the body can make some choline, this synthesis is inadequate to meet human needs and choline must therefore be consumed in the diet. Fortunately, it’s found in a variety of foods, including liver, cod, salmon, scallops, shrimp, beef, chicken, eggs, milk, quinoa, wheat germ, cauliflower, peas, broccoli, and Brussels sprouts. Egg yolks are the most concentrated source of dietary choline.

The adequate intake for choline is 550 mg per day for males aged 19 and older, 425 mg per day for females aged 19 and older, 450 mg per day for pregnant women, and 550 mg per day for lactating women.43,46,47 Unfortunately, survey data indicate that choline intake of most Americans—including men, women, pregnant women, and older children—is well below this recommendation. Further, there’s evidence that the currently recommended adequate intake may not even be high enough to meet the needs of as much as 50% of the population who carry certain genetic variations.46 This is an example of nutrigenomics, which is the scientific study of how different foods and their individual components may interact at a molecular level with certain genes,
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thereby altering gene expression and impacting an individual’s health and disease risk.\textsuperscript{46,48} It’s believed that nutrigenomics plays a role in obesity, type 2 diabetes, cardiovascular disease, and certain cancers.\textsuperscript{48}

While it’s likely that most Americans are consuming too little choline, it must be noted that there is an established upper limit for choline, which is 3.5 g per day for adults.\textsuperscript{43,47} Intake above this level can cause hypotension; other effects include sweating, diarrhea, and the development of a fishy body odor.\textsuperscript{43,47}

\textbf{Resources}

\textit{Choline Facts}

"If you focus on real food, nutrients tend to take care of themselves."

\textbf{Dr. David Katz}

Though the science of nutrition may seem overwhelming, eating a healthy diet that provides all of the essential nutrients doesn’t have to be super complex and calculated. Choosing a wide variety of whole foods helps ensure adequate intake of all of the vitamins, minerals, and macronutrients that our bodies need to feel good and function optimally. You’ll learn more about healthy diet patterns in the following lesson.

\textbf{Resources}

\textit{Food and Nutrition Information Center: Dietary References Intakes}


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\textsuperscript{2} Clark, N. (2008). *Nancy clark’s sports nutrition guidebook* (4\textsuperscript{th} ed.). Champaign, Ill: Human Kinetics.


http://www.nal.usda.gov/fnic/DRI/DRI_Tables/DRI_RDAs_Adequate_Intakes_Total_Water_Macronutrients.pdf


