

FOOD & NUTRITION: MICRONUTRIENTS



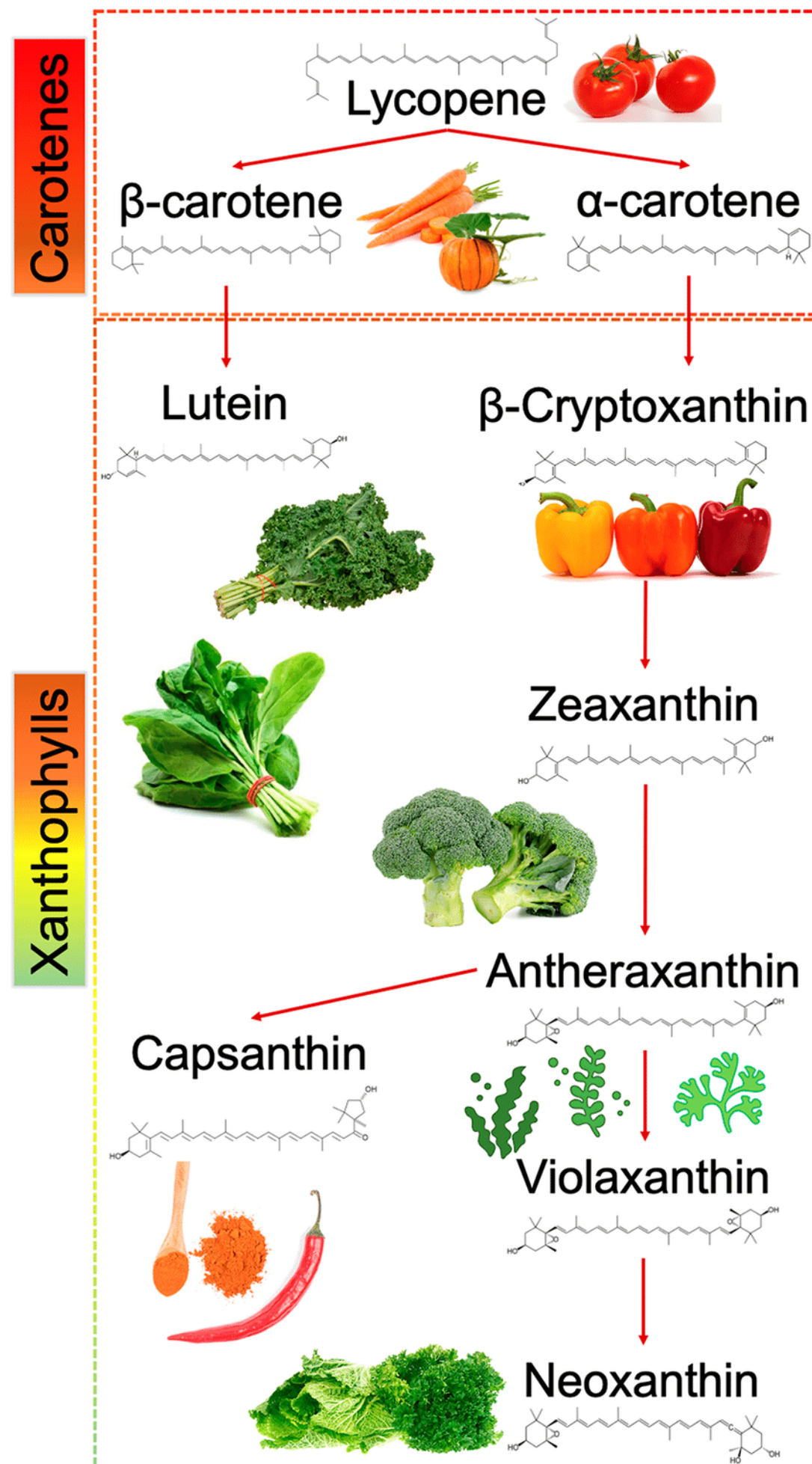
Genesis School of Natural Health

MICRONUTRIENTS

- Vitamins (fat-soluble and water-soluble)
- Minerals (microminerals and trace minerals)
- Phytonutrients / Phytochemicals (carotenoids, flavonoids, ellagic acid, etc.)

Vitamins and minerals are organic compounds that our bodies are unable to produce - it is essential that they are in our diet.

Phytonutrients, also called phytochemicals, are not technically essential vitamins but they are crucial for health and the prevention of disease. They are naturally found in the same whole foods that supply the vitamins, minerals, protein, and complex carbohydrates.



VITAMINS

Vitamins are categorized as either fat-soluble or water-soluble.

Fat-soluble vitamins are stored in the body's liver, fatty tissue, and muscles. The four fat-soluble vitamins are vitamins A, D, E, and K. These vitamins require the presence of fat to be absorbed.



Water-soluble vitamins are not stored in the body. Any leftover or excess amounts leave the body through the urine. They have to be consumed on a regular basis, preferably daily, to prevent deficiencies. The exception to this is vitamin B12, which can be stored in the liver.

MINERALS



Minerals are inorganic elements in the soil and water. Plants absorb minerals from the soil, and animals obtain minerals by consuming plants or drinking mineral-rich water.

The mineral content of the soil varies on location and it affects the mineral levels in the plants grown there.

Minerals are split into two groups:
Macro (or major) and Trace.

13 ESSENTIAL VITAMINS

Vitamin A = our body converts beta-carotene into vitamin A

Vitamin C = ascorbic acid

Vitamin D = calcitriol / cholecalciferol

Vitamin E = d-alpha-tocopherol) -
synthetic vitamin E is dl-alpha-tocopherol

Vitamin K = K₁(phylloquinone) & K₂ (menaquinone)

Vitamin B₁ = thiamine

Vitamin B₂ = riboflavin

Vitamin B₃ = niacin

Vitamin B₆ = pyridoxine

Vitamin B₁₂ = methylcobalamin is the most common form of vitamin B₁₂ in the blood/serum

Pantothenic acid = B₅

Biotin = B₇ /vitamin H

Folate = B₉ - synthetic version is folic acid

DEFICIENCIES

Top Nutrient Inadequacy Rates in the U.S.



- 45% for Vitamin A
- 46% for vitamin C
- 95% for vitamin D
- 84% for vitamin E
- 60% for Magnesium
- 67% for vitamin K
- 44% for Calcium
- 95% for Potassium
- 90% for Choline

Common deficiencies in the U.S. also include iron, zinc, essential fatty acids, B6, Folate/folic acid, and B12.

FOLATE

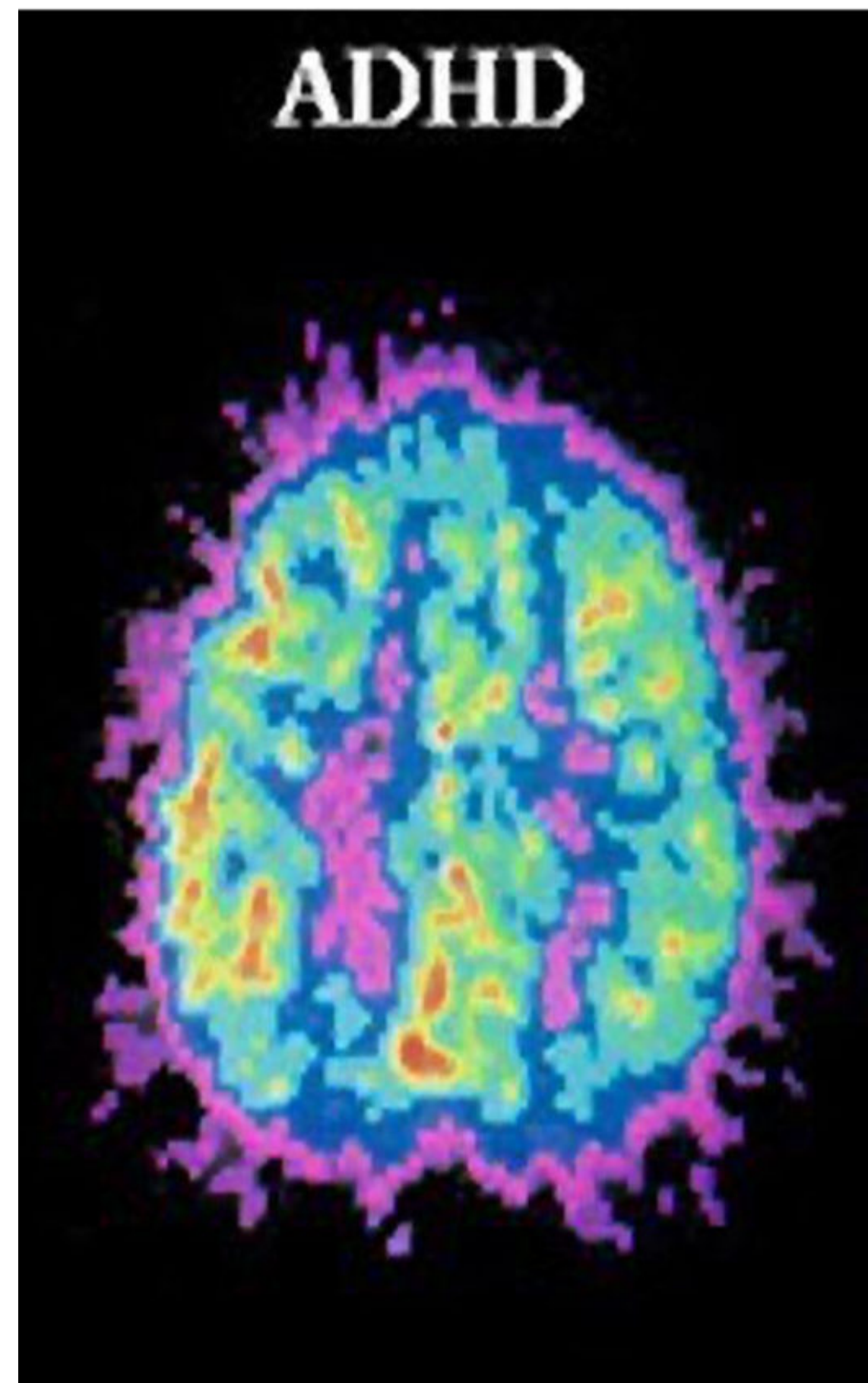
Folate is present in a wide variety of foods: vegetables (especially dark green leafy vegetables), fruit, nuts, legumes, seafood, eggs, dairy, meat, poultry, and grains.

Foods with the highest folate levels:

- Spinach, boiled (1/2 cup - 33%)
- Spinach, raw (1 cup - 15%)
- Black-Eyed Peas (1/2 cup - 26%)
- Asparagus (4 spears - 22%)
- Brussels Sprouts (1/2 cup - 20%)
- Romaine Lettuce (1 cup - 18%)
- Broccoli, cooked (1/2 cup - 13%)



FOLATE



ADHD is strongly associated with lower levels of folate. This association is independent of age and gender. Moreover, higher hyperactivity and peers relations problem in offspring are associated with lower maternal folate red blood cell and total folate in early pregnancy.

Folate administration is suggested for managing aggression. Folate deficiency is associated with aggression.

In addition, folic acid improves restless leg syndrome which is very common in children with ADHD.

<https://pmc.ncbi.nlm.nih.gov/articles/PMC3887226/>

Vitamin B6 (pyridoxine)

Foods with highest B6 levels:

Chickpeas, 1 cup - 65%

Beef liver, 3 oz. - 53%

Tuna, yellowfin, 3 oz. - 53%

Salmon, sockeye, 3 oz. - 35%

Chicken breast, 3 oz. - 29%

Potatoes 1 cup boiled - 25%

Turkey, 3 oz. - 25%

Banana, 1 medium - 25%

Ground beef, 3 oz - 18%

Bulgur, 1 cup - 12%

Cottage cheese, 1 cup - 12%

Squash, winter, ½ cup - 12%

The RDA for adults is 1.7 mg per day.

VERY LOW FOR MOST PEOPLE.

When using a B6 supplement, 15-35 mg per day is sufficient for most. There are individuals that may need 50 mg for 1-3 months before lowering the dose.

High doses (75-100 mg/day) of B6 can be problematic

Vitamin B6: Autism & ADHD

Vitamin B6 is important for the synthesis of many neurotransmitters (GABA, serotonin, noradrenalin, etc.). Vitamin B6 supplements can significantly reduce feelings of stress, anxiety, and depression and studies show that **vitamin B6 decreases behavioral problems for about half of autistic individuals.**



In several studies, **vitamin B6 and magnesium have been shown to reduce some of the symptoms of ADHD.** Symptoms of hyperexcitability such as physical aggression, attention at school, anxiety, and hypermobility seem to be the most significantly impacted. Children with ADHD tend to have a greater risk of vitamin B6 and magnesium deficiencies..

- <https://naturopathicpediatrics.com>

VITAMIN K



The most common foods with high vitamin K are green leafy vegetables such as kale, collard greens, broccoli, spinach, cabbage, and lettuce. The daily value for vitamin K is 120 mcg for adults and children age 4 years and older.

High Vitamin K foods (more than 100 mcg)

Food	Serving	mcg	Food	Serving	mcg
Asparagus, frozen	1 cup	144	Greens, turnip, cooked	1/2 cup	265
Broccoli, cooked	1/2 cup	110	Greens, turnip, frozen	1/2 cup	425
Broccoli, frozen	1 cup	162	Kale, cooked	1/2 cup	246
Brussels sprouts, frozen	1/2 cup	150	Onions, green or scallion	1/2 cup	103
Endive, raw	1 cup	116	Parsley, raw	2 Tbsps.	123
Greens, beet, cooked	1/2 cup	350	Spinach	1/2 cup	444
Greens, collard	1/2 cup	386	Spinach, raw	1 cup	145
Greens, collard, frozen	1/2 cup	530	Swiss chard	1/2 cup	287
Greens, mustard, frozen	1/2 cup	250			

VITAMIN-LIKE COMPOUNDS

There are a variety of organic compounds though cannot be defined as true vitamins, but are needed for the function of vitamins. In general, vitamin-like compounds are produced in the body and are not required in the daily diet. **Vitamin-like nutrients that are commonly studied include carnitine, inositol, alpha-lipoic acid, CoQ10, and choline.**

Carnitine is synthesized in the liver, kidneys, and brain from the amino acids lysine and methionine. It is a conditionally essential nutrient for those unable to produce enough (premature birth, kidney dysfunction, etc.). Carnitine play a major role in directing fatty acids to the mitochondrial membrane and preparing them to be used for energy.

Carnitine is abundant in beef, around 100 mg per 3 oz serving, but minimal in milk, chicken, fish, and vegetables. The primary signs of carnitine deficiency are muscle weakness, hypoglycemia, and cardiomyopathy (a thickened /hardened heart muscle).

Inositol is synthesized in the body and is used as a component of phospholipids in cell membranes where it plays a key role in the cell replication and cellular signaling. **Foods with the highest inositol amounts are green beans, artichokes, eggplant, okra, Brussels sprouts, cabbage, asparagus, and squash.**



Alpha-Lipoic Acid is produced by the mitochondria in our cells where it maintains biochemical reactions. Studies have found that alpha-lipoic acid supplements (300-600 mg) can help with neuropathy caused by diabetes or cancer treatment.

It is also neuro-protective, may slow cognitive decline, lowers heart disease risk factors, and it is a potent antioxidant and anti-inflammatory. **Red meat** (like beef) contains the highest amounts of alpha-lipoic acid available.

SPOTLIGHT: CHOLINE

Humans can produce choline in the liver, mostly as phosphatidylcholine, but not in an amount that is sufficient. Choline must also be consumed through our diet. The recommended daily intake for choline is **550 mg/day** for those over 4 years old.

The average daily choline intake for children and teens is 256 mg and women are are only averaging 278 mg per day.



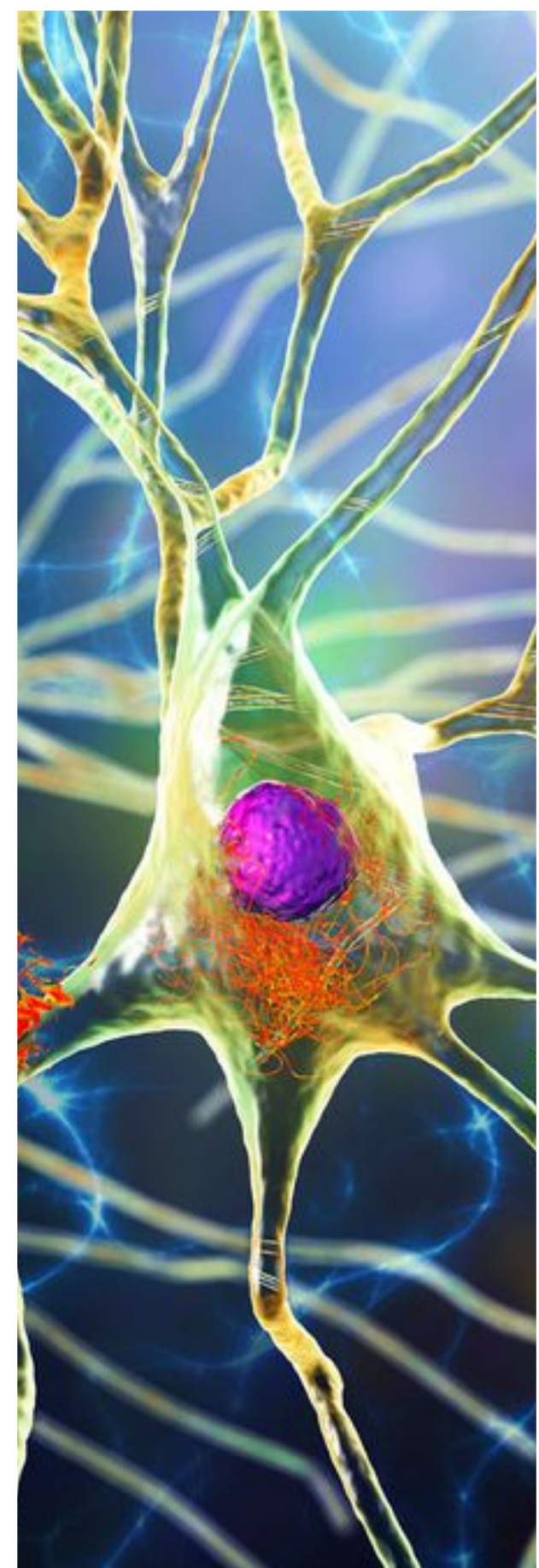
Approximately 90% of pregnant women are not consuming adequate amounts which is very concerning because choline is required for early brain development.

Choline is important for all stages of life.

- With the help of enzymes (choline acetyltransferases), choline is converted in the brain into acetylcholine. Acetylcholine is a neurotransmitter that plays a role in brain functions like short and long-term memory.
- Choline is required for regulating muscle contractions, blood pressure, and glandular secretions (saliva, sweat, digestive, adrenal, etc.).
- The body uses choline to produce the phospholipids that will become a part of our cell membranes and play a role in cell membrane signaling (cells communicate to coordinate body functions).

Choline deficiency can cause muscle damage, liver damage, and nonalcoholic fatty liver. Choline deficiency also alters DNA methylation and therefore gene expression. The result is increased mutation rates which can lead to the development of cancer.

CHOLINE & ALZHEIMER'S



People with Alzheimer's disease have lower levels of the enzyme choline acetyltransferase that converts choline into acetylcholine in the brain.

Phosphatidylcholine supplements may help in early onset dementia.

Phosphatidylcholine is also useful for hepatitis/liver inflammation, eczema, circulation problems, and premenstrual syndrome (PMS).

Studies have indicated that stomach acid reducing proton pump inhibitors (PPIs) may increase the likelihood of developing Alzheimer's disease and other forms of dementia.

PPIs inhibit the enzyme (choline acetyltransferase) which converts choline into acetylcholine. PPIs include omeprazole (Prilosec), esomeprazole (Nexium), lansoprazole (Prevacid), pantoprazole (Protonix), and rabeprazole (AcipHex).

Acetylcholine depletion is one of the best-documented hypotheses of delirium (a sudden and severe change in mental state, resulting in confusion, disorientation, and an inability to think clearly). It is also known that old age and anticholinergic medications can cause delirium.

Anticholinergic drugs include (there are many):



- Diphenhydramine (Benadryl, Tylenol PM, Advil PM, Unisom SleepGels)
- Brompheniramine (Dimetapp - a children's cold & allergy relief brand)
- Doxylamine (Unisom SleepTabs)
- Anticholinergic drugs are also used to treat chronic obstructive pulmonary disease (COPD), bladder conditions, gastrointestinal disorders, and more. For more information: <https://www.ncbi.nlm.nih.gov/books/NBK555893/>

CHOLINE FOODS

Daily Value for choline is 550 mg

Beef liver, 3 oz: 356 mg - 65%

Egg, hard boiled, 1 large: 147 mg - 27%

Beef top round, 3 oz: 117 mg - 21%

Soybeans, roasted, ½ cup: 107 mg - 19%

Chicken breast, 3 oz: 72 mg - 13%

Beef, ground (93%), 3 oz: 72 mg - 13%

Fish, cod, Atlantic, 3 oz: 71 mg - 13%

Wheat germ, toasted, 1 oz 51 mg - 9%

Beans, kidney, canned, ½ cup: 45 mg - 8%

Quinoa, cooked, 1 cup: 43 mg - 8%



**Various rices, beans, and vegetables
contain choline but at levels below
8% DV per serving.**

MINERALS



Minerals that are recognized as essential for health include calcium, phosphorus, potassium, sodium, chloride, magnesium, sulfur, cobalt, iron, copper, zinc, selenium, iodine, chromium, manganese, and molybdenum.

There are many minerals in our environment and whole foods, but only certain ones have been categorized as necessary for health. Sulfur (cruciferous vegetables) and boron are not listed on most essential mineral lists!

Note: The National Institutes of Health website says that scientists are studying boron to see if it affects health but low amounts may lower bone strength. There are many studies that support classifying boron as a necessary trace mineral.

SPOTLIGHT: BORON



Foods highest in boron:

- Avocados
- Prune juice
- Raisins
- Peaches
- Apples
- Broccoli

Studies show that a boron supplementation of **3 mg/d** is beneficial for any individual who is consuming a diet lacking in fruits and vegetables or who is at risk for or has osteoporosis, osteoarthritis, or breast, prostate, or lung cancer. - <https://pmc.ncbi.nlm.nih.gov/articles/PMC4712861/>

Boron has been proven to be an important trace mineral because it:



1. is essential for the growth and maintenance of bone
2. boosts magnesium absorption
3. greatly improves wound healing and reduces inflammation
4. beneficially impacts the body's use of vitamin D, estrogen, and testosterone
5. raises levels of antioxidant enzymes such as superoxide dismutase (SOD)
6. improves the brains electrical activity, cognitive performance, and short-term memory for elders
7. protects against pesticide-induced oxidative stress and heavy-metal toxicity, and more.

- <https://pmc.ncbi.nlm.nih.gov/articles/PMC4712861/>

ZINC DEFICIENCIES

Because zinc has many functions throughout the body, zinc deficiency affects many different tissues and organs. The most common symptoms of zinc deficiency include: Diarrhea, alopecia, delayed growth in children, loss of taste and smell, frequent infections, delayed wound healing, and it can change cognitive function in the elderly.

The following groups are among those most likely to have inadequate zinc status.

- **Individuals with gastrointestinal disorders** - Zinc inadequacy is common in people with inflammatory bowel diseases like ulcerative colitis and Crohn's disease, even when in remission. Almost 50% of people with diagnosed celiac disease have a zinc deficiency and the deficiency can persist even when foods containing gluten are avoided.
- **Individuals who have had bariatric surgery** involving resection of the gastrointestinal tract.
- **Vegetarians (especially vegans):** “The bioavailability of zinc from vegetarian diets is lower than from non-vegetarian diets because vegetarians typically eat large amounts of legumes and whole grains, which contain phytates that bind zinc and inhibit its absorption”. -- <https://ods.od.nih.gov/factsheets/Zinc-HealthProfessional>

ZINC: FOOD

The recommended daily amount of zinc is 8 milligrams (mg) for women and 11 mg for adult men.



Food	Milligrams (mg) per serving	Percent DV*
Oysters, Pacific, cooked, 3 ounces	28.2	256
Beef, bottom sirloin, roasted, 3 ounces	3.8	35
Blue crab, cooked, 3 ounces	3.2	29
Oatmeal, regular or quick, unenriched, 1 cup	2.3	21
Pumpkin seeds, roasted, 1 ounce	2.2	20
Pork, center loin (chops), 3 ounces	1.9	17
Turkey breast, 3 ounces	1.5	14
Cheese, cheddar, 1.5 ounces	1.5	14
Shrimp, cooked, 3 ounces	1.4	13
Lentils, boiled, ½ cup	1.3	12

CALCIUM

More than 99% of calcium in the body is in the form of calcium hydroxyapatite, an inorganic matrix of calcium and phosphate that is stored in the bones and teeth.

The recommended daily intake of calcium for adults is 1,000 mg/day up to the age of 50 and 1,200 mg/day after that.

The daily calcium recommendations take into account the bioavailability of calcium from different foods. Dairy foods (milk, yogurt, cheese) have a bioavailability of about 30%. This means that if a cup of milk contains 300 mg of calcium, the body will absorb about 100 mg. Leafy greens like broccoli, kale, and cabbage have a similar bioavailability to milk.

Calcium, taken as a supplement, should be limited to 500 mg per dose for proper absorption - excess calcium is excreted by the kidneys.

The bioavailability of calcium from food, and supplements like calcium carbonate, relies on the hydrochloric acid in the stomach. The acid ionizes calcium by removing any proteins attached to the calcium so it can be absorbed in the small intestine and transported to the blood.

Easily ionized forms of calcium supplements that don't rely on stomach acid include: calcium lactate, calcium citrate, and calcium malate. Many individuals only need to supplement 30%-50% of the recommended dose - even when they have osteoporosis. Food sources should be taken into consideration when supplementing.



Antacids and stomach acid reducing proton pump inhibitors decrease the amount of calcium that can be ionized and have been linked to an increase in bone fractures. In addition, inorganic phosphate additives in our processed foods have “detrimental effects on bone and mineral metabolism in humans and animals.” - <https://pmc.ncbi.nlm.nih.gov/articles/PMC5693714/>

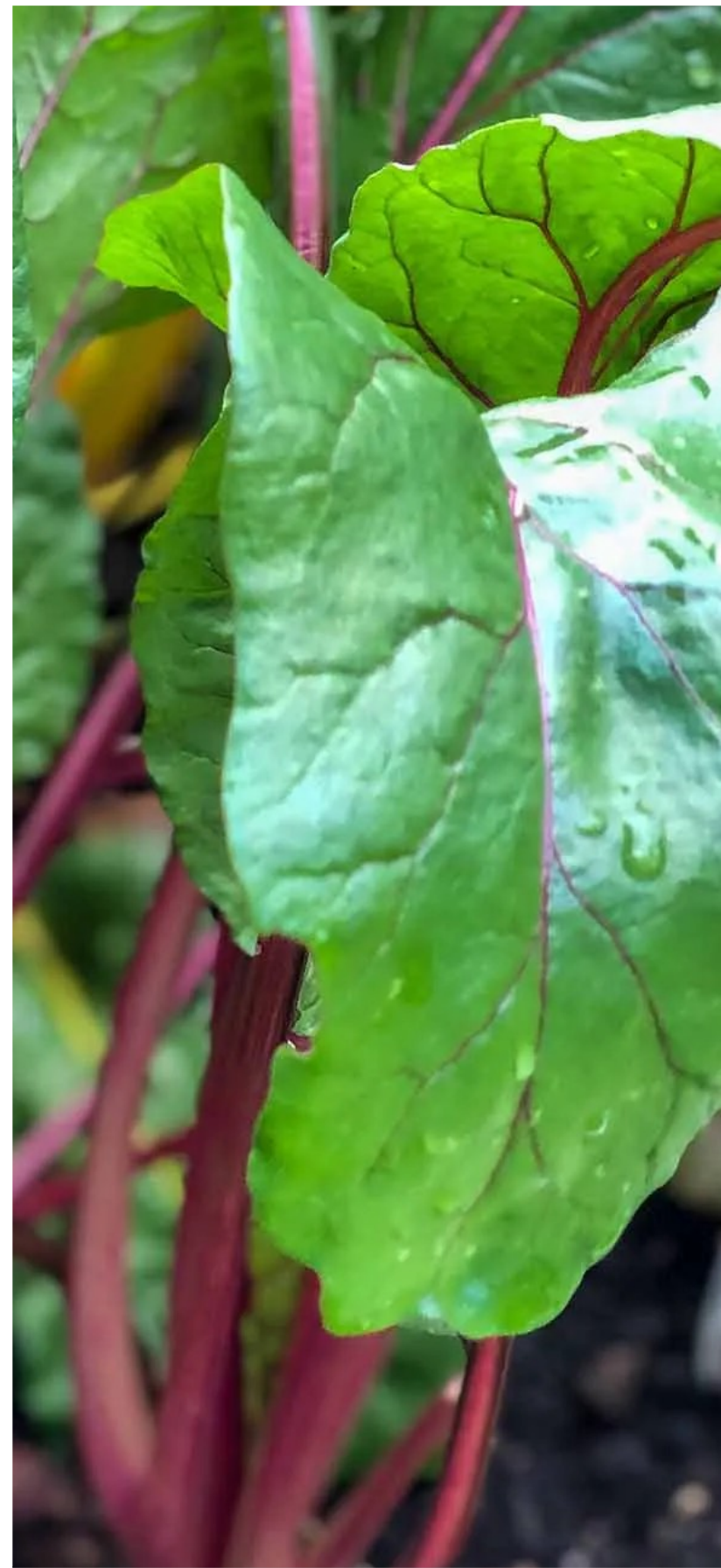
CALCIUM SUPPLEMENTS



Some studies suggest that supplemental calcium should not exceed 500-700 mg per day. Many studies have found that supplemental calcium at the recommended dose it leads to various conditions that include heart disease/hardened arteries, kidney issues, and colon polyps.

Erin Michos, MD, MHS , associate director of preventive cardiology for the Ciccarone Center for the Prevention of Heart Disease states that “...people believe that the proof that calcium supplements fortify bones is more robust than it really is,” she says. “The truth is, the research is inconclusive. But there is a growing body of evidence that suggests no health benefit, or even worse, that calcium supplements may be harmful.”

CALCIUM & OXALATES



Oxalate levels are high in some green leafy vegetables (spinach, Swiss chard), navy beans, nuts (almonds, Brazil nuts, pine nuts), beets (especially the leafy tops), dates, rhubarb, and soy products. Oxalates bind to the calcium within the food and prevent most of it from being absorbed.

According to the University of Arizona Extension, the oxalates in spinach mainly bind to the calcium in the spinach and **not the calcium found in other foods eaten at the same meal.** Eating a variety of foods and not consuming huge amounts of any one food will eliminate most problems that arise from various phytochemicals.

CALCIUM & PHYTATES



Phytates (phytic acid) in whole grains, seeds, legumes, some nuts **can decrease** the absorption of iron, zinc, magnesium, and calcium. Some fibers, like wheat bran fiber, will also **decrease** the absorption of calcium.

**Decreased absorption is not the same
as binding all of the minerals.**

“When people eat many different types of foods, these interactions with oxalic or phytic acid probably have little or no nutritional consequences”. - <https://ods.od.nih.gov/factsheets/Calcium-HealthProfessional/>

PLANT CALCIUM



Calcium, while in small amounts per normal serving size, is found in a variety of nuts, seeds, and vegetables. Including: kelp, pulse, parsley, carob flour, Brazil nuts, watercress, sunflower seeds, buckwheat, broccoli, walnuts, pecans, romaine lettuce, apricots, green beans, cabbage, celery, cashews, carrots, sweet potatoes, and more.

Tofu 350 mg per ½ cup serving

Tapioca 300 mg per ½ cup serving

Chia seeds 300 mg per 1.5 ounces serving

Collard greens 210 mg per ½ cup serving

Kale 205 mg per ½ cup serving

Bok Choy 190 mg per ½ cup serving

Figs 135 mg per 5 fig serving

White Beans 120 mg per ½ cup serving

Turnip Greens 104 mg per ½ cup serving

Spinach 99 mg per ½ cup serving

Almonds 93 mg per ¼ cup serving

Sesame Seeds 51 mg per 1 TBSP serving

POTASSIUM

Potassium inadequacy is at 95% in the U.S. but our foods should easily supply more than enough. Almost every fruit and vegetable contains potassium!

What depletes potassium in the body? Sodium, alcohol, caffeine, gut inflammation, low magnesium, and diuretics used for high blood pressure are the most common substances that lower potassium or cause the body to excrete more than it should.

Great potassium sources include:

- Fresh Fruit
- Dates & Figs
- Cooked spinach
- Cooked broccoli
- Cauliflower
- Potatoes
- Sweet potatoes
- Tomatoes (cooked)
- Mushrooms
- Peas and Beans
- Cucumbers
- Zucchini
- Pumpkins / Squash
- Leafy greens
- Burdock root
- Alfalfa
- Nettles
- Parsnips

PHYTONUTRIENTS / PHYTOCHEMICALS

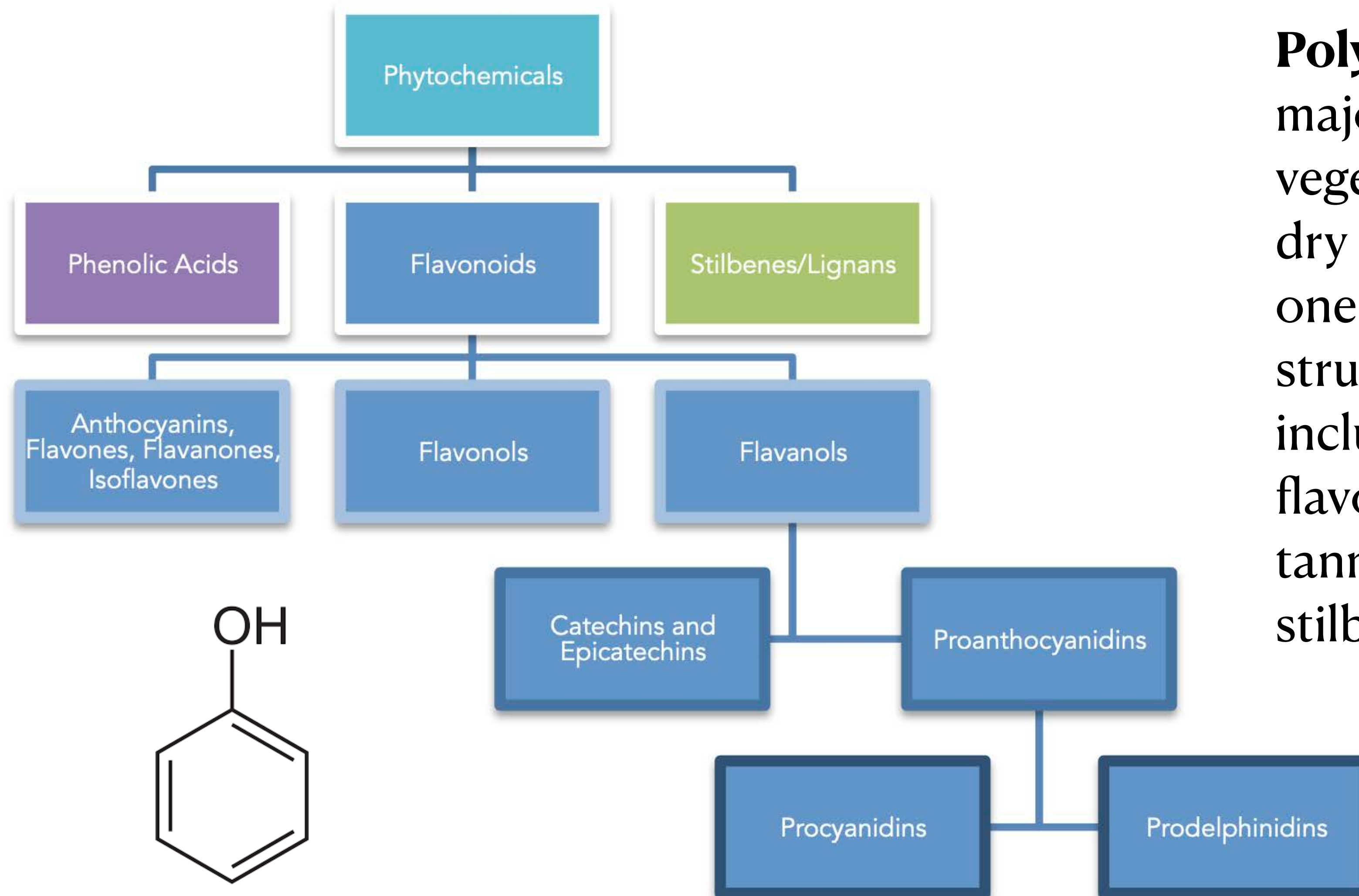
Macronutrients (protein, fats, and complex carbohydrates), vitamins, and minerals are the basics of nutrition. Most of us grew up knowing that fruits and vegetables were healthy and we needed to eat them but, we didn't know why they were so important.

Research into only a few of the thousands of plant chemicals has revealed that the benefits of eating whole foods goes far beyond the action of vitamins and minerals. Whole foods also provide thousands of phytonutrients, also called phytochemicals.

Phytonutrients provide the antiviral, anti-inflammatory, anticancer, antimicrobial, and antioxidant properties of our foods. It is not necessary to memorize all the names of the chemicals but it helps to understand a few of the larger categories.

Categories we will look at include polyphenols, carotenoids, and glucosinolates.

POLYPHENOLS / PHENOLIC COMPOUNDS



Polyphenols is one of the major classes of compounds in vegetables, fruits, cereals, and dry legumes that have at least one phenol group in their structure. A category that includes, phenolic acids, flavonoids, flavanols, catechins, tannins, lignans, anthocyanins, stilbenes, etc.

PHENOLIC ACIDS

Phenolic acids are aromatic secondary plant metabolites and non-flavonoid polyphenols. They are further classified as hydroxybenzoic acids (gallic, vanillic, protocatechuic, salicylic acid, etc.) and hydroxycinnamic acids (cinnamic, rosmarinic, p-coumaric, ferulic, caffeic, chlorogenic acid, etc.).



The highest concentration of phenolic acids are found in the seeds, fruit skins, and the leaves. The major dietary sources of phenolic acids include fruits, nuts, whole grains, cocoa, and coffee. Chamomile, chicory, dandelion, artichoke, yarrow, mugwort, and wormwood are great sources of caffeoylquinic acid which is a potent antioxidant. Phenolic acid supplements include grape seed and green tea extracts.

PHENOLIC ACIDS



The most dominant TASTES contributed to phenolic acids are bitter and astringent. For example, green tea contains phenolic compounds that contribute to its bitterness and astringency.

Phenolic acids properties include antioxidant, anti-inflammatory, immunoregulatory, anti-allergenic, anti-atherogenic, anti-microbial, anti-thrombotic, cardioprotective, and antidiabetic. They also have anti-cancer activities. (Anantharaju et al., 2016, Kumar and Goel, 2019).

STILBENES



Stilbenes are especially abundant in red grapes, pistachios, peanuts, rhubarb, blueberries, bilberries, mulberries, bicolor sorghum, conifer tree bark, *Polygonum cuspidatum* (Japanese knotweed), and *Humulus lupulus* (hops).

Stilbene's have antioxidant, anti-cancer, and anti-inflammatory properties.

Resveratrol is the most well-known stilbene and was a key factor in how wine contributed to the French paradox (high intake of saturated fat but low mortality from coronary heart disease).

Food research determined that dietary patterns rich in resveratrol significantly reduced all-cause mortality. Resveratrol also showed potential to improve cardiovascular disease risk factors by significantly decreasing fasting blood glucose, triglycerides, and heart rate. <https://pmc.ncbi.nlm.nih.gov/articles/PMC7143620/>

LIGNANS

There are 2 groups of polyphenols that are known as phytoestrogens:

Isoflavones and Lignans

The main lignan in flaxseed is SDG (secoisolariciresinol diglucoside) and the main lignan in sesame seeds is sesaminol. The five-flavor herb Schisandra contains lignans referred to as schisandrol. Foods with the highest levels of lignans include:



Flax Seeds (ground) richest source

Sesame Seeds (ground, Tahini)

Brassica family / Cruciferous vegetables

Cashew nuts

Relatively high content of lignans: brown rice, red rice, quinoa, millet, barley, buckwheat, wild rice, spelt, and oats

LIGNANS

In addition to phytoestrogen properties, lignans are also anti-viral, antioxidant, anti-inflammatory, prebiotic, and anti-cancer.

Lignan research studies were few until they discovered mammalian lignan formation. Researchers found that lignans from flax seeds were converted into enterodiol and enterolactone **by gut microbiota**. Enterodiol and enterolactone can reduce the risk of various cancers such as breast, colon, and prostate cancers.

“A new study demonstrates that the human gut microbiome may be a factor in breast health... In the study, flaxseed components called lignans were shown to influence the relationship between gut microorganisms and the expression of mammary gland microRNAs (miRNAs). A subset of these miRNAs regulates the genes involved in breast cancer, including genes that control cell proliferation and migration.” <https://asm.org> - Microbiology Spectrum

FLAVONOIDS

Flavonoids are the largest group of phenolic compounds. They play an important role in decreasing disease risk by providing antiviral, anti-inflammatory, cytotoxic, antimicrobial, and antioxidant effects that slow the aging process and decrease the risk of allergies, heart disease, tumors, and blood clots. Flavonoids decrease heart disease risk by improving endothelial function, decreasing blood pressure, and improving insulin resistance.



Some examples of flavonoids and their food sources:

- **Quercetin** (flavonol): citrus fruits, apples, onions
- **Catechin** (flavanol): chocolate, tea, coffee
- **Genistein** (isoflavone): fava beans, soybeans, red clover, alfalfa
- **Hesperetin** (flavonone): citrus fruits: oranges, lemons, grapefruit
- **Cyanidin** (anthocyanidin): berries

ANTHOCYANINS

Anthocyanins common in our diets include: cyanidin, delphinidin, malvidin, pelargonidin, peonidin, and petunidin. Anthocyanins are water-soluble pigments that contribute to the deep red, purple, and blue colors in fruits, flowers, and vegetables.



Foods high in anthocyanin content: elderberries, blueberries, blackberries, cranberries, hibiscus flowers, cherries, grapes, black currants, purple cabbage, black/purple carrots, black plums, red onions, plums, eggplants, and more.

Blueberries are one of the richest sources of anthocyanins among common fruits and they contain five out of the six anthocyanins - all except pelargonidin.

ANTHOCYANINS

Anthocyanins modulate cognitive and motor function which enhances memory and prevents age-related declines in neural function (to think, feel, move, and sense the world around us). They also reduce inflammation, free radicals, pancreatic swelling, lipid peroxidation, and blood sugar concentrations in the urine and blood.

“The antimicrobial activity of anthocyanins in general has been well established, including **significant inhibition of aflatoxin** biosynthesis”. - <https://pmc.ncbi.nlm.nih.gov/articles/PMC1082894/>



Aflatoxins, also called mycotoxins, are produced by certain fungi that are commonly found on crops such as corn, peanuts, cottonseed, and tree nuts. The main fungi that produce aflatoxins are *Aspergillus flavus* and *Aspergillus parasiticus*.

AFLATOXINS - MYCOTOXINS

Aflatoxins are poisonous carcinogens that cause cancer, most notably liver cancer.

Aflatoxin-producing fungi can contaminate crops in the field, at harvest, and during storage. The crops commonly infected in the U.S. include peanuts, corn, cottonseed, and tree nuts. Exposure to aflatoxins can also occur by consuming meat or dairy products from animals that ate contaminated feed.



It is not possible to remove all aflatoxins from the food supply so a limit has been established for food products. USDA - “The standard for aflatoxins is 20 ppb for human food and animal feeds (corn and other grains) intended for immature animals or unknown destinations”.

Fungicides are extensively used but, like pesticides, there are health consequences.

CAROTENOIDS

While most of the polyphenols (phenolic acids, flavonoids, anthocyanins, etc.) are water-soluble compounds, the carotenoids are fat-soluble. Carotenoids are the yellow, orange, and red pigments produced by plants and fungi and they are found in the chloroplasts of green plants.



Carotenoids: Carotenes and Xanthophylls

- The most common carotenes in our diets are alpha-carotene, beta-carotene, and lycopene.
- The most common xanthophylls are lutein and zeaxanthin.
- ALL carotenoids are best absorbed with fat in a meal. In addition, chopping, puréeing, and cooking carotenoid-containing vegetables in oil increases the bioavailability of the carotenoids.

CAROTENOIDS & CANCER

Research into lycopene, alpha-carotene, beta-carotene, and other carotenoids has received a lot of attention because of their potential to reduce the risk of breast and prostate tumors. Carotenoids have the ability to inhibit cell growth (anti-proliferative), reduce reactive oxygen species (free radicals), and improve immune function.

The antitumor activities of brown algae, a traditional Japanese food with a high content of carotenoids, especially fucoxanthin, has also attracted attention in cancer research. Fucoxanthin is a **brown-colored xanthophyll carotenoid** abundant in brown macroalgae such as *Dictyota*, *Fucus*, *Laminaria*, *Sargassum*, and others.

Many fruits and vegetables contain carotenoids but high levels are found in carrots (alpha- and beta-carotenes) and tomatoes (lycopene).

<https://pmc.ncbi.nlm.nih.gov/articles/PMC7563597/>

α -CAROTENES and β -CAROTENES

- **Provitamin A** carotenoids (α -carotene, β -carotene, β -cryptoxanthin) are converted into vitamin A (retinal) in the intestinal mucosa and then transported to the liver for storage. **Preformed vitamin A** comes from animal products, especially liver, fish, eggs, and dairy products.
- β -carotene stimulates the proliferation, increases the amount, of lymphocytes (white blood cells); reduces lipid (fat) oxidation; activates cell communication; reduces inflammation; and improves cardiovascular health.
- In addition, studies suggest that β -carotene may help strengthen the intestinal barrier which **reduces the permeability** of the gut lining. Some research indicates that β -carotene may influence the composition of **gut microbiota** by promoting the growth of beneficial bacteria like *Bifidobacterium* and *Lactobacillus*.

BETA-CAROTENES

The foods highest in beta carotene:

- Carrots
- Sweet Potatoes
- Dark leafy greens
- Broccoli
- Pumpkin / Squashes
- Cantaloupe
- Peppers (sweet or hot)
- Apricots
- Peas
- Romaine lettuce



Herbs that contain beta-carotene:

- Paprika
- Cayenne
- Coriander/Cilantro
- Parsley
- Cilantro
- Marjoram
- Sage
- Many more....

WINTER SQUASH



Winter squashes are beautiful, delicious, and nutritious. Don't throw away the nutrient dense seeds! The most common varieties include butternut, delicata, spaghetti, kabocha, acorn, hubbard, and sugar pumpkins. They are excellent sources of carotenoids, vitamin B6, fiber, magnesium, and potassium.

Diabetes: “Squash is a dense, filling food despite being fairly low in calories (45-90 calories per cup cooked, depending on type) with a **low glycemic index and load**. Butternut squash, for example, has almost half the amount of carbohydrate of a sweet potato. Squash also contains polysaccharides, a type of indigestible fiber that can prevent blood sugar from rising after eating, as shown in animal studies.”

- <https://nutritionsource.hsph.harvard.edu/food-features/winter-squash>

SQUASH: SEEDS

- Both summer and winter squash seeds are nutritionally dense. Most types of squash seeds contain fiber, protein, healthy fats, carotenoids, vitamins C, K, B6, and folate, calcium, magnesium, iron, potassium, phosphorus, zinc, and selenium.
- Pumpkin seeds contain proteins that have anti-peroxidative properties that help improve liver function and detoxification. Anti-peroxidative refers to the ability to neutralize free radicals that oxidize lipids, especially cell membrane lipids.
- Toasted squash seeds will keep for weeks in the refrigerator.
- Pepitas and pumpkin seeds are closely related. Pumpkin seeds are whole seeds with their shells still on, whereas pepitas are found in shell-less, or hullless pumpkin varieties. Pepitas have less fiber because the hulls contain much of the fiber.

LYCOPENE

Lycopene protects cells from the oxidative damage of cell lipid, proteins, and DNA. It also reinforces the immune system, prevents skin damage, and inhibits cancer cell growth. Lycopene is not converted into vitamin A.

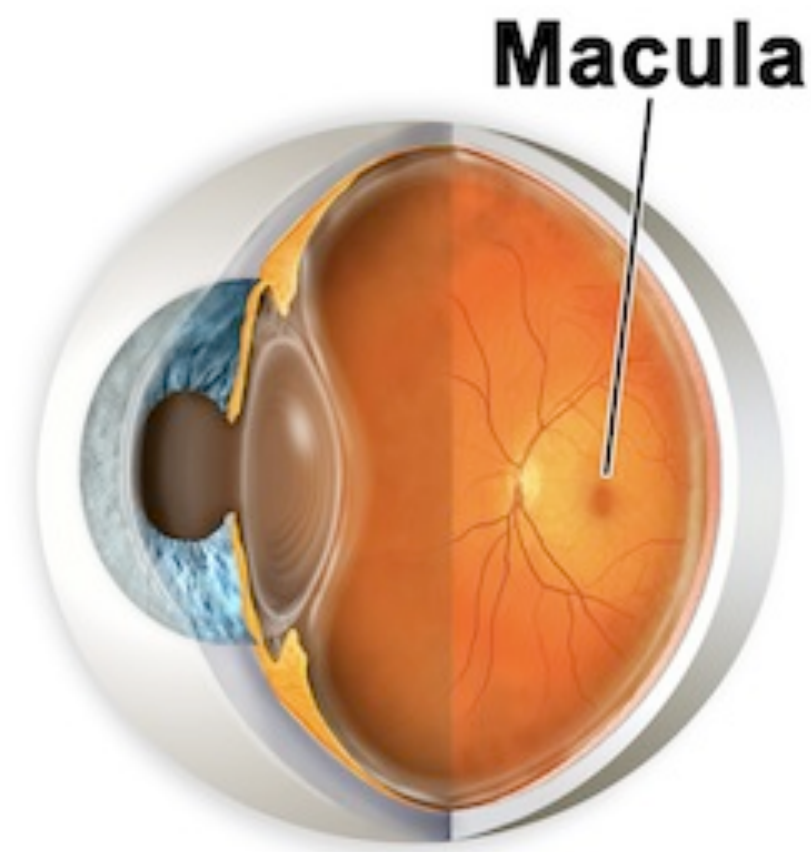


Tomatoes contain an abundance of lycopene and cooking them increases the bioavailability of the lycopene. Optimal absorption requires at least a tablespoon of fat with the meal.

Lycopene is also found in red, pink, and orange fruit and vegetables. Rich fruit sources include apricots, melons, papayas, grapes, peaches, watermelons, and cranberries.

XANTHOPHYLLS

Xanthophylls, lutein and zeaxanthin, have orange to yellow pigments. They are actively taken up into the macula of the eye where they absorb up to 90% of blue light and prevent macular degeneration and cataracts. In addition, lutein and zeaxanthin reduce the risk of heart disease and breast cancer.



- Consuming at least 6 mg of lutein in your diet each day can decrease your risk of developing macular degeneration by 43%.
- Studies show that lutein may improve cognitive performance by boosting brain activity, memory, and verbal fluency.
- Both lutein and zeaxanthin are antioxidants that protect your skin cells from ultraviolet sun damage and slow signs of aging.

XANTHOPHYLLS



Lutein is in most fruits and vegetables, but green and yellow foods have the highest amounts.

Dark green leafy vegetables like spinach and kale are particularly rich sources of lutein but poor sources of zeaxanthin.

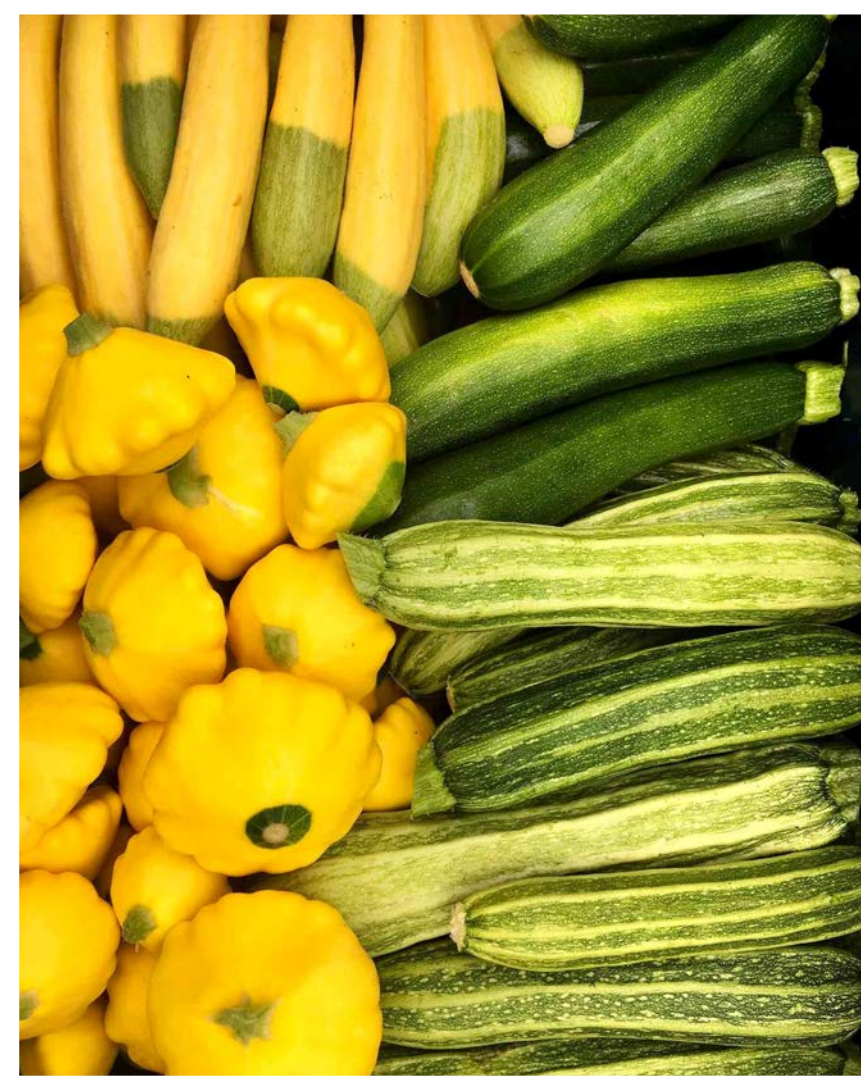
Egg yolks and avocados have low amounts of lutein but it is highly bioavailable.

Other good sources of lutein and zeaxanthin include yellow corn, romaine lettuce, bell peppers, parsley, and pistachios.

Methods used to determine the amount of lutein and zeaxanthin in food do not always separate the two nutrients. Reports will often say lutein and zeaxanthin instead of how much of each individual nutrient.

SUMMER SQUASH

Summer squashes come in all shapes and sizes and contain many phytonutrients. They are rich source of potassium and magnesium, vitamins, carotenoids (beta-carotene, lutein, zeaxanthin), and contain the anti-inflammatory polysaccharide homo-galacturonan, a type of pectin that influences immunity and our microbiota.



- Zucchini
- Chayote squash (mirliton)
- Cousa (looks like spaghetti squash)
- Crookneck squash
- Pattypan
- Tatum - Mexican heirloom (also called calabacita)
- Tromboncino - Italian heirloom

LUTEIN: LEAFY GREENS

- **Spinach** has a mild taste and can be eaten raw or cooked. Baby spinach is more tender and mild-tasting than full grown spinach.
- **Kale** is a member of the cabbage family with long, curly leaves. Remove the tough center stalks before cooking. Prepare the same way you would spinach. It's good in salads, omelets, pastas, stir-frys and soups. You can also use it raw in salads.
- **Arugula** (rocket) has tender leaves with a sharp mustard or peppery flavor and are usually tossed with other lettuces in salads.
- **Rapini** (broccoli raab) Looks like thin broccoli stalks with small clusters of buds and smooth leaves. It's very popular in Italian cooking where it is steamed, sautéed or braised.
- **Swiss Chard** has a mildly sweet yet slightly bitter flavor with large green (and sometimes red, orange and yellow) ribbed leaves and thick stalks. Leaves can be used in salads and both leaves and stalks can be steamed or sautéed.

LUTEIN: LEAFY GREENS

- **Bok Choy** is a member of the cabbage family and is tasty in stir-frys, salads, soup or as a quick side dish. .
- **Dandelion Greens** are slightly bitter. Older dandelion greens should be cooked; younger ones can be cooked or served raw as a salad green. You can substitute them for any recipe that calls for kale, collards, Swiss chard, spinach and rapini.
- **Collard Greens** are a variety of cabbage that does not form a head, but instead has long and flat leaves. They taste similar to cabbage or kale. Collards taste milder when they are cooked (they can be bitter when raw).
- **Mustard Greens** are dark green and have a strong mustard flavor. Try the leaves steamed or sautéed and flavoured with garlic or onion. You can eat them raw but they taste milder when cooked. Use in any dish where you would add kale or spinach.

LETTUCES



In general, lettuces can be placed into four categories: looseleaf, butterhead, crisphead, and romaine. They contain many nutrients, including lutein and zeaxanthin.

The common iceberg lettuce is an example of a crisphead (round head of tightly packed leaves). Butterheads are also round, but the leaves smooth and much looser than the crisped lettuces.

Romaine stands out with its elongated leaves with a thick white rib.

Looseleaf lettuces grow as a rosette with loosely gathered leaves. This makes it easy to remove the leaves as needed instead of harvesting the whole plant. You will find them packaged as mixed baby lettuce or spring mix in grocery stores.

SPOTLIGHT: CELERY

Celery is an aromatic root vegetable that belongs to the same family (Apiaceae) as carrots, parsnip, fennel, parsley, and cumin. The celery root (celeriac) has a mild taste that can be used as a substitute for potatoes, even mashed potatoes. It is often sautéed or baked/roasted with other vegetables.

- Celery leaves are high in potassium and zinc.
- Celery stalks are high in calcium and sodium.
- Celery seeds are high in phosphorus and iron (0.41-0.56 mg/g).
- Celery leaves, stalks and seeds also contain magnesium, manganese, vitamins A, K, and C, folate, and pantothenic acid.



SPOTLIGHT: CELERY

Celery stalks, leaves, seeds, and essential oils are used for both food and in traditional medicine. Celery research supports its use to prevent cardiovascular and liver diseases, urinary tract obstruction, gout, and rheumatic disorders. Phytochemicals include limonene, selinene, furocoumarin glycosides, and flavonoid.



“Celery reduces glucose, blood lipids, and blood pressure, which can strengthen the heart... its essential oils have antibacterial effects. Its seeds are useful in the treatment of bronchitis, asthenopia, asthma, chronic skin disorders, including psoriasis, vomiting, fever, and tumors. The root of the celery is diuretic and it is used for the treatment of colic. - <https://journals.sagepub.com/doi/10.1177/2156587217717415>

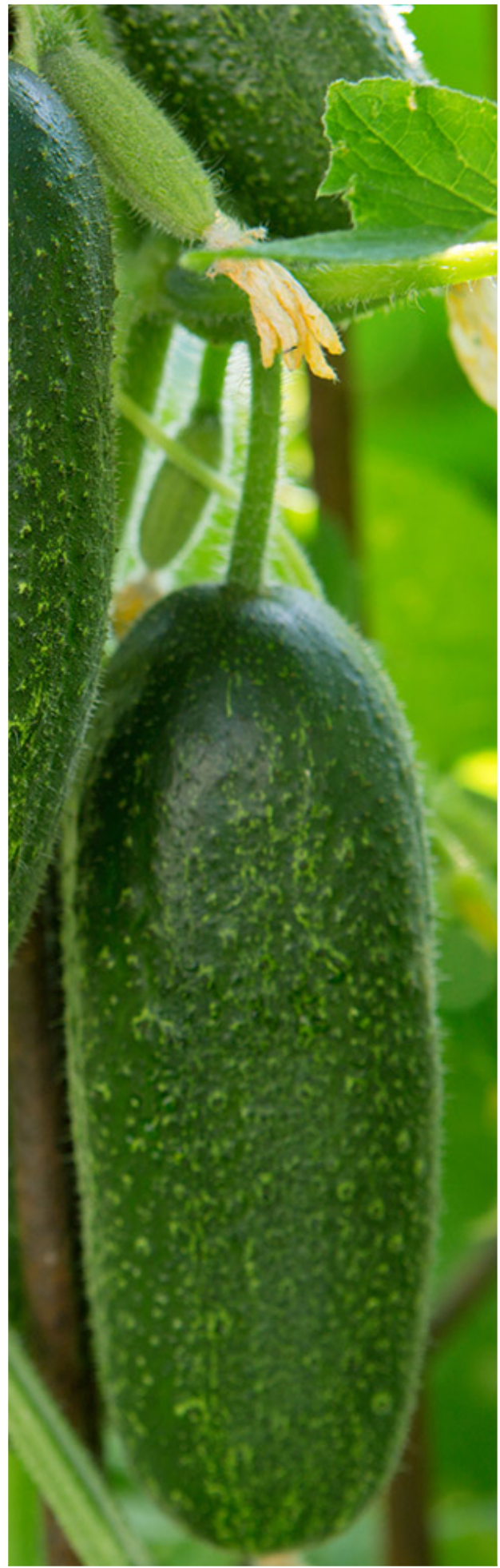
SPOTLIGHT: CELERY

The ethanol extract of celery **leaves and roots** showed antimicrobial activity against several bacteria such as *Enterococcus faecalis*, *Escherichia coli*, *Enterobacter aerogenes*, *Salmonella typhimurium*, *Bacillus cereus*, *Citrobacter freundii*, *Proteus vulgaris*, *Listeria monocytogenes*, *Hafnia alvei*, and *Staphylococcus aureus*.

In addition, the ethanol extract of celery leaves was more efficient and effective than the dry root ethanol extract of celery. The higher doses of ethanol extract from celery leaves and roots showed higher antimicrobial activity. Celery extract can also inhibit the growth of the bacteria *Citrobacter freundii* and *Proteus vulgaris*.

<https://www.sysrevpharm.org/articles/review-on-the-pharmacological-and-health-aspects-of-apium-graveolens-or-celery-an-update.pdf>

SPOTLIGHT: CUCUMBERS



The cucumber/cucubit family (Cucurbitaceae) includes summer squashes, winter squashes / pumpkin, watermelon / melons, cantaloupe, and, of course, cucumber.

The peel and seeds are the most nutrient-dense parts of the cucumber. They provide flavonoids, beta-carotene, vitamins A, B, C, and K1, and minerals like magnesium, potassium, and calcium. Cucumbers are antioxidant, anti-inflammatory, antacid, hepatoprotective, antibacterial, antidiarrheal, and may have anti-clotting effects.

Cucumbers are one of best alkaline-promoting foods and can counteract an acidic pH in the kidneys. They also have a diuretic effect which can help with kidney function. Eating cucumbers on a regular basis can help regulate uric acid levels, prevent uric acid kidney stones and prevent calcium oxalate kidney stones.

Topically, cucumbers can help with skin problems like sunburn, swelling under the eyes, and acne. For acne, the cucumber is sliced thinly and gently rubbed on the acne areas. After it dries rinse with warm water. Use caution on a sensitive face.

SPOTLIGHT: CUCUMBERS

Cucurbitacin is a bitter compound found in cucumbers (and other cucurbits). It is concentrated in the roots, leaves, and stems of the plant but can spread into the fruit (mostly the skin) when the plant is stressed. There are some people who can't tolerate cucumbers - they cause digestive upset that leads to a lot of burping, bloating, and gas.

“Wild cucumbers have a large amount of cucurbitacin [enough to make you throw up], which discourages feeding by wild animals and insects. Today's hybrids have been bred to have lower amounts of cucurbitacin in the fruit and what cucurbitacin is in the plant is concentrated in the roots, leaves, and stems. In instances where the bitter compound is in cucumbers, it is more prevalent in the stem end than the blossom end... Misshapen fruit will also have more cucurbitacin than normal-shaped ones”. - <https://extension.unl.edu/statewide/dodge/cucumber-bitterness/>

CRUCIFEROUS VEGETABLES

Cruciferous vegetables (Brassicaceae) contain a wide variety of vitamins, minerals, and phytonutrients like carotenoids. What sets them apart from other vegetables are their glucosinolate compounds (sulforaphane and indole-3-carbinol).



- Kale and Arugula (rocket)
- Watercress
- Mustard greens and Collards
- Cabbages and Bok choy
- Brussels sprouts
- Cauliflower and Broccoli
- Kohlrabi, Turnips, and Rutabaga
- Radish, Wasabi, and Horseradish

GLUCOSINOLATES

Sulforaphane is antioxidant, anti-inflammatory, and may prevent numerous types of cancers, including prostate, breast, liver, and colon. Sulforaphane and indole-3-carbinol inhibit prostate cancer by both blocking initiation and suppressing prostate cancer progression in vitro and in vivo. Research has largely focused on the anti-initiation and cytoprotective effects of sulforaphane and indole-3-carbinol **through induction of phases I and II detoxification pathways...** - <https://pmc.ncbi.nlm.nih.gov/articles/PMC3787240/>

The recommended daily intake of indole-3-carbinol is typically 20–120 mg. One head of cabbage contains approximately 1200 mg of indole-3-carbinol. Supplements are available, however, consuming foods high in glucosinolates provides many other synergistic phytonutrients that support healthy cells.

GLUCOSINOLATES

Sulforaphane has biological properties that may be relevant to neurological and psychiatric conditions. Potential mechanisms include the modulation of the hypothalamic-pituitary-adrenal axis and inflammatory pathways. Sulforaphane may diminish neuro-inflammation, reduce beta-amyloid production, and increase blood brain barrier integrity.

Research suggests that glucosinolates and their metabolites found in cruciferous vegetables are important for the prevention and treatment of several chronic diseases.

Glucosinolate metabolites, particularly sulforaphane, may exert a beneficial effect on neurological and psychiatric conditions, such as depression, schizophrenia, autism, Alzheimer's disease, and multiple sclerosis. Sulforaphane has also been indicated as an important dietary component for musculoskeletal disorders..."

- <https://www.frontiersin.org/journals/pharmacology/articles/10.3389/fphar.2021.767975/full>

DAILY PHYTONUTRIENTS



Consuming a minimum of 6 to 9 servings of fruits and vegetables per day, with the emphasis on non-starchy vegetables, will provide a substantial amount of nutrients.

- Cruciferous vegetables & leafy greens: 4+ servings
- Fresh (or frozen) fruit: 1-3 servings
- Starchy vegetables (sweet potato, squash...): 1-2 servings

An 80 gram portion of fruit and vegetables equals approximately one small banana, apple, pear or large mandarin. Three heaped tablespoons of cooked vegetables count as a portion. Clients need to understand portions!

CONSUMING PHYTONUTRIENTS

Eating 800 grams (28 ounces) of fruits and vegetables a day is associated with a:

- 33% reduced risk of stroke
- 31% reduction in dying prematurely
- 28% reduced risk of cardiovascular disease
- 24% reduced risk of heart disease
- 13% reduced risk of total cancer



MACRONUTRIENTS REVIEW

Total Fats: 44-78 grams per day

- Saturated (long-chain, medium-chain, short-chain)(ideally around 10% of total fat)
- Unsaturated (monounsaturated/omega-7 and omega-9)(polyunsaturated/ omega-6, omega-3 as alpha-linoleic acid, and omega-3 as EPA and DHA)

Protein: RDA (weight x 0.36 = grams per day)(140 pounds = 50.4 grams)

- The RDA is the minimum to not get sick!
- MayoClinic: 10% to 35% of your calories should come from protein. So if your needs are 2,000 calories, that's 200–700 calories from protein, or 50–175 grams.
- Amino Acids: Essential, Conditionally Essential, and Non-Essential

Fiber: 28-34 grams per day

Water/Fluids: 12-16 cups per day depending on activity levels

THANK YOU FOR JOINING OUR LECTURE!



SUPER-SEEDED MUESLI BARS

Makes about 16 bars

- 1 cup shredded coconut
- ½ cup each sultanas, pumpkin seeds and sunflower seeds
- ¼ cup each black chia seeds and white sesame seeds
- ⅓ cup each tahini and honey
- 3 tablespoons coconut oil
- 1 teaspoon each vanilla extract and ground cinnamon
- ½ teaspoon sea salt

Grease an 8" x 8" square baking tin and line with baking paper. Preheat the oven to 325°F. Combine the coconut, sultanas and seeds in a large bowl. Put the tahini, honey, coconut oil, vanilla, cinnamon and salt in a small saucepan over a medium heat. Cook, whisking, until the mixture is bubbling and smooth. Pour onto the seed mixture and stir until everything is well coated.

Press the mixture firmly into the tin. Bake for about 20 minutes, or until golden. Let cool completely in the tin. Lift out and cut into small squares. Store them in the fridge so they are extra crunchy to eat.

<https://dish.co.nz/recipes/super-seeded-muesli-bars/>