

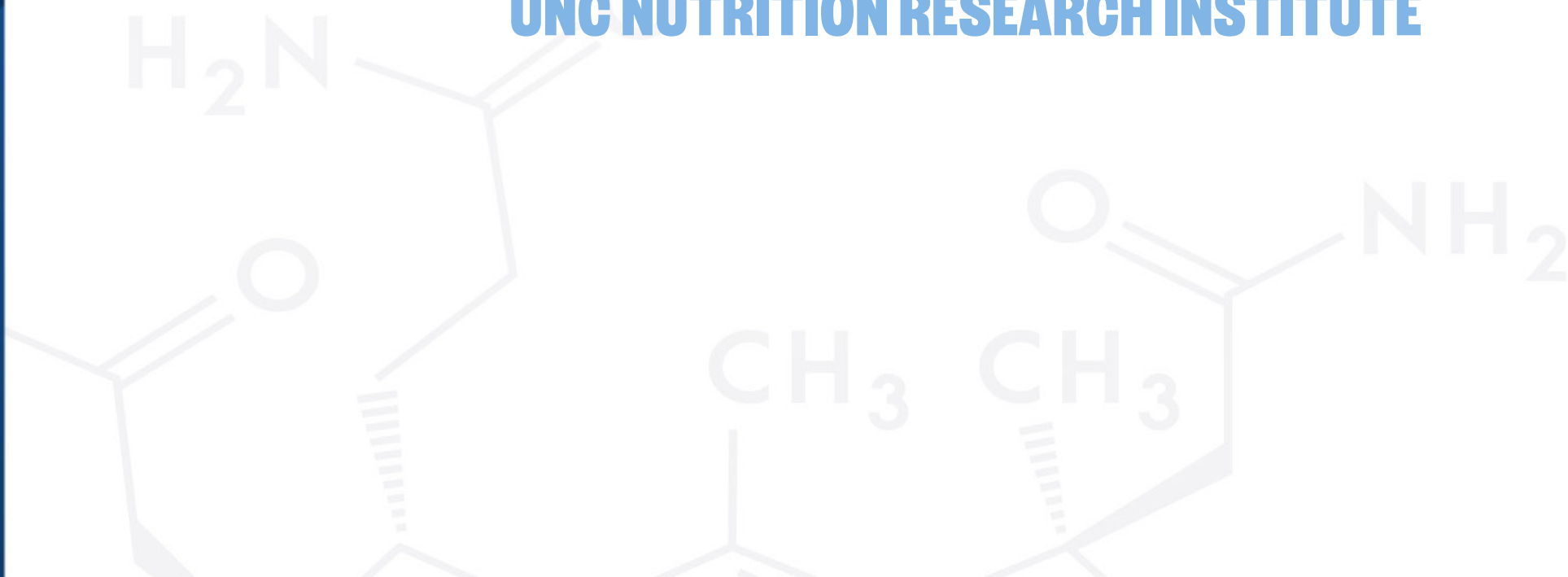


The University
of North Carolina
at Chapel Hill



VIRTUAL INTERNSHIP PROGRAM
UNC NUTRITION RESEARCH INSTITUTE

Nutrition Research Institute
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Kannapolis, NC 28081
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VIRTUAL INTERNSHIP PROGRAM
UNC NUTRITION RESEARCH INSTITUTE

What is VIP?

Our Virtual Internship Program is offered to high school students (those entering 9th grade through recent graduates entering their freshman year of college in the fall of 2026). This four-week program provides opportunities to learn from NRI principal investigators, participate in group mentoring sessions, and complete an independent nutrition research paper and presentation.

To successfully complete the program, students must attend all scheduled lectures and mentoring sessions. This year, the program featured six sessions across four weeks, lasting at least one hour each.

Leading these sessions were:

Deborah Tate, PhD, *NRI Interim Director, Professor of Nutrition and Health Behavior*

Jenna Baker, *VIP Coordinator*

Carsyn Patton, *VIP Coordinator*

Sandra Mooney, PhD, *VIP Coordinator, Associate Professor of Nutrition*

Melody Burke, *Assistant Director, Office of Undergraduate Admissions*

Ximena Bustamante-Marin, PhD, *Assistant Professor of Nutrition*

Carol Cheatham, PhD, *Associate Professor*

Ryan Dayvault, *Associate Director of Operations and Planning*

Walter Friday, *Research Specialist, Trujillo and Saini Labs*

Carol Munson, *Research Specialist, Mooney Lab*

Hannah Petry, *Graduate Research Assistant, Mooney Lab*

In the fourth week, students presented their posters to their peers and NRI scientists and staff. You're invited to read over their posters in this booklet.

Disclaimer

This journal is a student-created publication and the content within may not be entirely accurate. The articles and opinions expressed here do not reflect the official research, views, or positions of the UNC Nutrition Research Institute (NRI). Readers are encouraged to consult verified sources for accurate information.

“As a trailblazer in precision nutrition research, the UNC Nutrition Research Institute investigates the intricate interplay between nutrients, lifestyle behaviors, environmental influences, genetic and other biological factors. We’re dedicated to unraveling the mysteries of nutritional diversity among individuals.”

- Deborah Tate, PhD,
NRI Interim Director, Professor of
Nutrition and Health Behavior

ABOUT THE NRI

The UNC Nutrition Research Institute is an internationally recognized center that conducts innovative basic and translational science studying how individual differences in requirements and responses to diet affect our individual nutritional needs. We believe that our advances in nutrition science are leading to successes in preventing or mitigating the negative effects of chronic diseases and aging and in improving human development, even prior to conception.

MISSION

To understand how nutrition affects individual health through our leadership in precision nutrition research, establishing how differences in our genes, bacteria, metabolism, and environment shape our individual disease risk.

VISION

To use scientific discovery to ensure optimal health through individualized nutrition.

GUIDING SCIENTIFIC PREMISE

Each of us is metabolically unique. The NRI is dedicated to answering the question of how these differences affect an individual’s health, and, in so doing, update the current but outdated paradigm of a singular dietary guideline with specific nutritional recommendations and actions by which an individual can improve his or her health and quality of life.

Learn more at: [UNCNRI.org](https://www.uncnri.org)

Caffeine

Student Name: Bhavya Lodha

Student Name: Annie Thomas

NUTRIENT INTRODUCTION

Caffeine is a psychoactive stimulant that is found in a majority of foods and beverages. It is a bitter white powder with the chemical name: 1,3,7-trimethylxanthine. The word "caffeine" originated from the Arabic word "qahweh", which represents the spread of coffee from Arabia and Turkey to Europe and other continents. Before caffeine, the umbrella term was coffee, and in 1819, caffeine became isolated from coffee. Caffeine is a stimulant that helps improve mood and is consumed very often by people, being the most popular psychoactive drug consumed in the world.

WHY IT'S IMPORTANT

Up to 400mg, drinking coffee on an empty stomach can give one an energy boost. Additionally, some coffee drinkers, especially women, are less likely to die of coronary heart disease, stroke, diabetes, and kidney disease. Additionally, it may also be linked to reduced risk of Parkinson's disease, type 2 diabetes, Alzheimer's, metabolic syndrome, liver cancer and disease, and gallstones. In some groups within studies, drinking coffee can improve mood in moderation as well as alertness and focus by blocking adenosine, which is a neurotransmitter that makes one feel tired.

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HOW IT WORKS

Caffeine is usually absorbed in the body around 45 minutes after it is consumed, and is mainly broken down in the liver. It can remain in the blood for about a maximum of 9.5 hours. While in the bloodstream, Caffeine stimulates the Central Nervous System, causing effects of alertness to occur when consumed. It blocks adenosine receptors in the body, which helps reduce tiredness and sleepiness, increasing overall attentiveness.

TOO MUCH/TOO LITTLE

While minimal amounts of caffeine, up to 400 mg a day, can be a helpful stimulant that awakens the body, too much caffeine can heavily impact mood, even giving one feelings of anxiety and insomnia. Continued use can also lead to one building tolerance, so more caffeine must be consumed to actually have an effect. At this point, too little caffeine can lead to irritability, headache, agitation, depressed mood, and tiredness. If one is pregnant, uptake is limited to 200 mg a day, as caffeine can harm a baby's sleep and may cause complications such as birth defects, miscarriage, and preterm birth.

FUN OR HISTORICAL FACTS

- “Caffeine is currently the most consumed psychoactive drug”
- “Over 90% of adults in the US consume caffeine daily.”
- Caffeine is not only found in food and beverages, but also in some medications, as it is used to provide effective relief from pain and headaches
- Taking caffeine later in the day can degrade quality of sleep
- Decaffeinated does not always mean no caffeine! Some decaffeinated drinks might also just have less caffeine than regular caffeinated drinks.

FOOD SOURCES

Unprocessed sources:

- Tea leaves
- Kola nuts
- Cocoa beans
- Coffee

Processed sources:

- Espresso
- Chocolate
- Guarana
- Energy Drinks
- Supplements



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Calcium

Student Name: Rakshana Prabhu

Student Name: Eunhae Han

NUTRIENT INTRODUCTION

- Calcium, referred to as Ca, is the 20th element within the Periodic Table. [14]
- It is a vital mineral gained through exogenous sources such as food and vitamins. [9]
- Within our body, it is typically found in the form of Calcium Hydroxyapatite or $(Ca_{10}[PO_4]_6[OH]_2)$, within our bones and teeth. [2]
- The recommended amount of Calcium is 1000mg/day, however, this amount can vary based on age range, typically increasing for older individuals and pregnant women. [14] [5]
- Externally, it is found in compound forms within various rocks, food items, and shells of marine organisms. [16]

WHY IT'S IMPORTANT

- Adequate amounts of calcium in the body allow increased bone strength and structure. [5]
- Calcium also allows for muscles to move, nerves to carry messages throughout the body, and even helps blood vessels move blood around the body. [5]
- Calcium helps to decrease the risk of preeclampsia and maternal morbidity. [12]
- Calcium also helps cholesterol metabolism, with decreased low density lipoprotein and increased high density lipoprotein. [12]
- Calcium is utilized for hormone secretion as well. [5]

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HOW IT WORKS

- **Digestion:** In the process of digesting Calcium, Gastric acids made within the stomach are used to break Calcium down into its ionized form, prior to being transported to the intestines. The ionized form of Calcium (Ca^{2+}) is the form required for intestinal absorption. [1]
- **Absorption into the bloodstream:**
 - Passive Paracellular Transport: Relies on the concentration gradient formed by concentration of Calcium ions to flow between enterocytes to enter the bloodstream. [7]
 - Active Transcellular Transport: Following the entry of calcium across the brush border aided by the ion channel CaT1, it travels through the cell by binding to a protein known CalbindinD(9K), before finally being released into the bloodstream. This process is regulated by Vitamin D which triggers the expression of vital proteins required to absorb Calcium (such as those mentioned above). [6] [7]
- **Metabolism:** Calcium is metabolized through a negative feedback loop that takes place when regulating Calcium levels in the bloodstream. [8] [10]
 - Lack of Calcium: Results in release of PTH (Parathyroid Hormone), which signals osteoclasts to break down bone tissue releasing calcium. As levels of calcium normalize, release of PTH decreases. [8]
 - Excess Calcium: Results in release of Calcitonin by the Thyroid gland, which results in inhibition of osteoclasts, allowing deposit of excess calcium into bones by osteoblasts to lower calcium levels in the blood stream. As levels of calcium normalize, release of Calcitonin decreases. [10]

TOO MUCH/TOO LITTLE

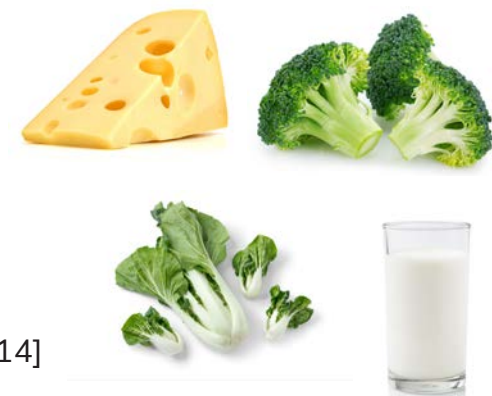
- Having too much calcium in the body, although not necessarily from high intakes of calcium as much as high levels of parathyroid hormone or cancer, can lead to unusual heart rhythms, kidney issues, nausea, low phosphate levels, poor muscle function, weight loss, and even risk of death from heart disease. [5]
- However, if the body has less calcium than is needed, recent studies show that hypocalcemia increases lipogenesis, which in turn will increase obesity (a large cause of metabolic disorders in females). Also, children may not be able to grow their height to their full potential if they do not have enough calcium. Growth is negatively impacted and bones become weak, making the risk of breaking bones higher. [11] [9]

FUN OR HISTORICAL FACTS

- The word calcium is derived from a Latin prefix that means lime ("Calx" or "Calci"). This choice in name was provided by Sir Humphrey David in 1808 following his isolation of Calcium from limestone. [2]
- A metadata analysis conducted by professionals as listed within the NIH and PubMed Central showed that countries that proved to consume 1000mg or greater a day are majorly in Northern Europe. In places such as South East Asia, South Asia, East Asia, consumption of calcium remained at or under 500mg a day. South Africa and South America consume between 400-700mg a day on average. [3]

FOOD SOURCES

- Milk [9]
- Yogurt [9]
- Cheese [9]
- Kale (frozen) [14]
- Bok Choi (cooked, boiled) [14]
- Broccoli [5]
- Turnip Greens [9]
- Sardines [9]
- Canned Salmon (with bones) [14]



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Cholesterol

Student Name: Lucia Parodi

Student Name: Devyani Gaonkar

NUTRIENT INTRODUCTION

Cholesterol is a waxy substance that our bodies produce in the liver among other organs. The word "cholesterol" comes from ancient Greek, connecting "chole", "stereos", and the chemical suffix of "ol". Belonging to the steroid family, cholesterol is present in all animal tissue. Although consumption of cholesterol is significant in the current human diet, there is no need for intake of excess cholesterol, as a healthy human body makes enough on its own. Therefore, excessive cholesterol intake may lead to different consequences for the human body, such as the increase of cholesterol levels to an unhealthy level. Since cholesterol isn't soluble in the bloodstream, it must be transported by complexes called lipoproteins. Different types of lipoproteins may exhibit different effects on the human body.

WHY IT'S IMPORTANT

Your body needs cholesterol to perform important jobs. For example, cholesterol is needed to build the cell membranes for cells, which guard what can enter or leave the cell. Cholesterol also helps the liver to make bile in order to break down food after eating. It even serves as a building block for certain hormones (estrogen, testosterone, cortisol) and vitamin D. Maintaining healthy cholesterol levels is essential for cardiovascular health. High cholesterol itself often has no symptoms, but over time, it contributes to the narrowing and hardening of arteries (atherosclerosis), leading to serious conditions such as heart attacks and strokes.

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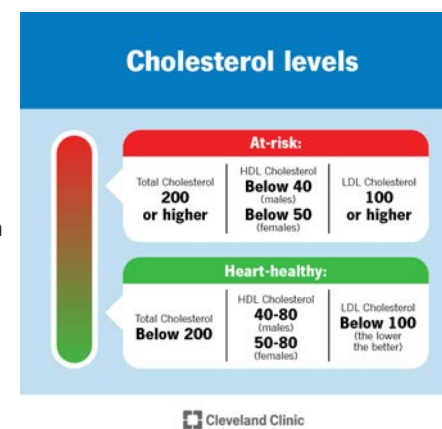
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HOW IT WORKS

Dietary cholesterol is absorbed in the small intestine after being consumed. Then, the cholesterol is packaged into small lipoprotein particles called chylomicrons, where it is then transported to the liver through the bloodstream. Instead of obtaining cholesterol by consumption, cholesterol is processed in the liver through harnessing byproducts of essential nutrients such as glucose, carbohydrates, and fats that we eat in our everyday diets. The liver may use the cholesterol to help create vitamin D, cell membranes, and hormones. However, cholesterol may also be stored or transported. If the cholesterol is being transported, it then circulates in our blood with the help of lipoproteins. There are more than two types of lipoproteins, but the main ones are HDL and LDL. Low-density lipoproteins may carry the LDL cholesterol from one part to other parts of your body. Excess LDL may contribute to the buildup of plaque (fat and cholesterol) in artery walls, which could lead to strokes and heart attacks in the long run. However, high-density lipoproteins act similar to sponges, soaking up excess cholesterol from the body and carrying it back to the liver to be flushed out.

TOO MUCH/TOO LITTLE

Cholesterol levels are important because they help determine the risk for heart disease. Having too much cholesterol in the blood, especially low-density lipoprotein (LDL) cholesterol, can be harmful. It can lead to plaque building up in arteries, which increases the risk of heart disease, heart attacks, and strokes. It is especially dangerous because high cholesterol usually has no symptoms, which is why doctors use blood tests to measure it. Very low LDL is rare, but may be associated with hormone imbalances, difficulty producing Vitamin D, problems absorbing fats, and even developmental issues in some cases.



FUN OR HISTORICAL FACTS

- There are no warning signs for high cholesterol
- Cholesterol levels increase with age
- Cholesterol was first identified in 1769 by François Poulletier de la Salle
- Diet only affects 20 to 30 percent of cholesterol in our blood

FOOD SOURCES

Plants produce cholesterol, but in extremely small amounts (hundreds or thousands of times less than animal products). Because of this, plant foods are generally considered cholesterol-free, and animal products are considered high in cholesterol. Foods high in saturated fats, like red meat, processed meats, full-fat dairy, and commercially baked goods, are rich in them. Some foods, like eggs and shellfish, are high in cholesterol but are relatively low in saturated fat and thus can be enjoyed in moderation as part of a balanced diet.

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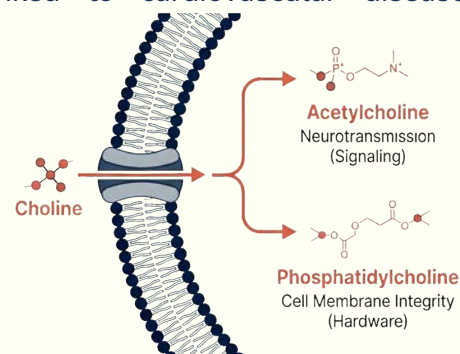


How is Choline Digested, Absorbed, and Metabolized?

Choline is consumed in several chemical forms, including free choline, water-soluble forms such as glycerophosphocholine (GPC), and lipid-soluble forms such as phosphatidylcholine (lecithin). Enzymes in the digestive tract help release choline-containing molecules from food. In the small intestine, pancreatic enzymes such as phospholipase A₂ break down lipid-soluble forms of choline such as phosphatidylcholine, allowing it to be absorbed by intestinal cells. Upon absorption, some choline enters the bloodstream as free choline, while phospholipid forms of choline may be repackaged into lipoproteins and transported through the lymphatic system. Choline travels mainly to the liver once absorbed, where it becomes central to several metabolic pathways. It can be oxidized into betaine, which donates methyl groups for reactions such as the conversion of homocysteine into methionine; or used to synthesize acetylcholine, a neurotransmitter involved in memory, muscle contraction, and nerve signaling. A portion of unabsorbed choline may also be metabolized by gut bacteria into trimethylamine (TMA), which the liver converts into trimethylamine N-oxide (TMAO).

Deficiency & Toxicity

Choline deficiency leads to lowered acetylcholine levels in the body, causing muscle aches, muscle damage, and fatigue. Additionally, hepatic steatosis, or fat accumulation in the liver cells, can occur because the liver becomes unable to synthesize phosphatidylcholine, an essential lipid required to build and package very-low-density lipoproteins, which transport triglycerides out of the liver and into the bloodstream. Pregnant women are prone to choline deficiency. Supplementation of choline may be needed during pregnancy to meet the recommendation of 450 mg per day and to avoid developmental issues of the fetal hippocampus, spinal cord, and neural tube. Choline toxicity can cause a fishy body odor, sweating, vomiting, and low blood pressure. Additionally, excess choline is broken down by gut bacteria into trimethylamine, which the liver then must oxidize into trimethylamine-N-oxide, a compound linked to cardiovascular disease and liver dysfunction.



Choline



Presenters: Saumya Anand and Avani Mehta

What is Choline?

Choline is an essential, water-soluble organic compound with the molecular formula C₅H₁₄NO⁺. Although technically neither a vitamin nor a mineral, choline is associated with the B vitamins because it performs similar functions. Choline participates in reactions involving cell membrane protection, neurotransmitter production, and metabolism. In the body, choline exists both freely and as part of larger molecules such as phosphatidylcholine, which is a major phospholipid in cell membranes. Once absorbed, choline can be converted into the neurotransmitter acetylcholine, which is needed for nervous system functioning. Choline is especially important in rapidly developing tissues, including the fetal brain and nervous system. This makes choline vital during pregnancy, as it is needed to build the hippocampus of the developing fetus and prevent against neural tube defects. In fact, the amniotic fluid contains concentrations of choline up to 10 times higher than the mother's blood, which highlights how heavily fetal development depends on choline, especially during periods of rapid brain and nervous system growth.

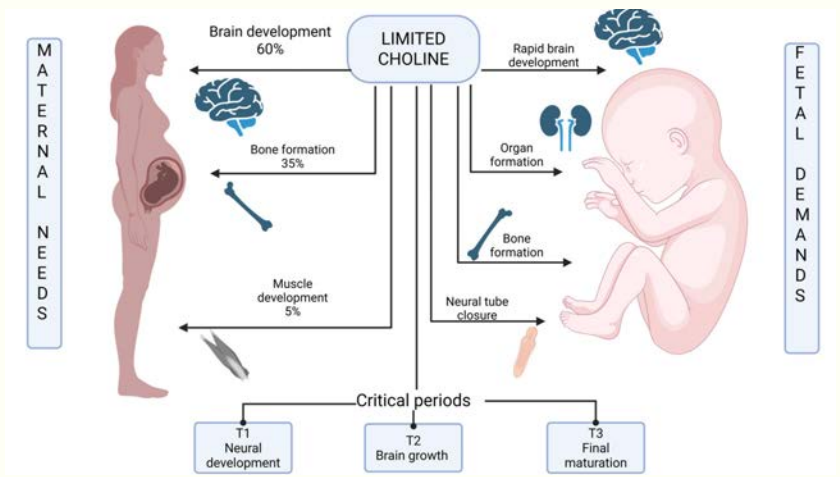
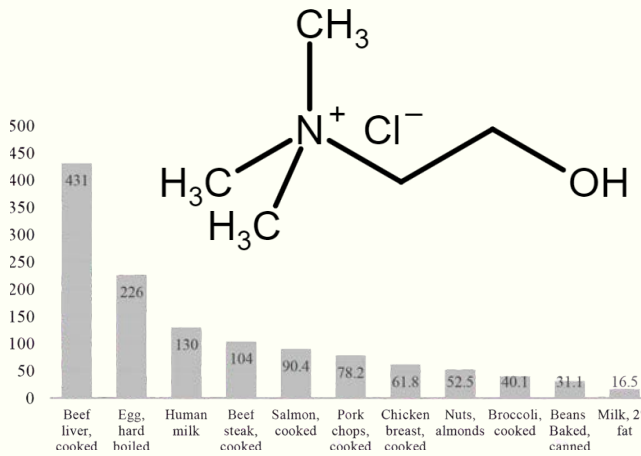
Dietary Sources

| | | | |
|--|------------------------------------|--|--------------------------------|
| | Beef liver, 3 ounces 65% DV | | Cod Fish, 3oz. 13% DV |
| | 1 large egg, hard boiled 27% DV | | Potatoes, 1 large 10% DV |
| | Soybeans, 1/2 cup 19% DV | | Wheat Germ, 1 oz. 9% DV |
| | Chicken breast, 3 oz. 13% DV | | Kidney Beans, 1/2 cup 8% DV |

| Age | Male (mg/day) | Female (mg/day) | Pregnancy (mg/day) |
|-------------------|---------------|-----------------|--------------------|
| Birth to 6 months | 125 | 125 | |
| 7-12 months | 150 | 150 | |
| 1-3 years | 200 | 200 | |
| 4-8 years | 250 | 250 | |
| 9-13 years | 375 | 375 | |
| 14-18 years | 550 | 400 | 450 |
| 19+ years | 550 | 425 | 450 |

DV stands for Daily Value, representing U.S. FDA's standard daily intake recommendations for nutrients for a 2000-cal diet. Over 90% of the population fails to consume enough choline. Because choline is found in higher amounts in many animal products, vegans and vegetarians may need to be especially mindful of their intake.

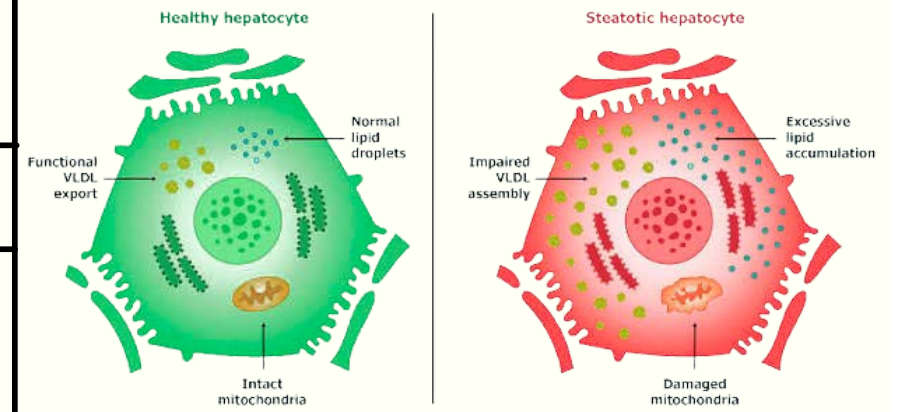
Choline mg per 100 g weight



Importance

Choline supports cell membranes and liver function, aids in brain and nerve signaling, and helps with methylation and metabolism. Inadequate choline is linked to fatty liver disease, muscle damage, altered lipid metabolism, and possible developmental concerns during pregnancy. Its metabolism is also connected to trimethylamine N-oxide or TMAO, a compound being studied for links to cardiovascular health issues.

Impact of choline deficiency on liver function



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What Foods Should You Eat To Boost Your Choline Levels? Cleveland Clinic. <https://health.clevelandclinic.org/choline-foods>

The nutrient copper uses in the body.

Student Name: Madi Canipe

Student Name: Nikith Neela
DOC LINK

NUTRIENT INTRODUCTION

Copper is an essential trace mineral available in foods and dietary supplements. Its major role in the body is as a co-factor for several enzymes involved in the reactions of iron metabolism, energy production, and neurotransmitter synthesis. Copper also plays a vital role in many other life processes, such as blood vessel development, nerve cell hormone homeostasis, brain development, and functioning of the immune system.

The name copper comes from the name of a Greek island of Cyprus, Kyprios, where copper occurs. In Latin, Cuprum or Cu, means metal of Cyprus where Rome had many copper mines.

WHY IT'S IMPORTANT

Uses of copper in the body

1. Iron Metabolism and Red Blood Cell Production
Copper is linked and required to maintain iron homeostasis as it plays a role in oxidizing iron through multi-copper oxidases (MCOs), which are copper-dependent ferroxidases that function in iron homeostasis. MCOs oxidizes ferrous iron (Fe²⁺) to the ferric (Fe³⁺) which is a form that can be bound to transferrin (the main iron carrier) and transported throughout the body allowing hemoglobin proteins in red blood cells to use iron to transport oxygen. With copper deficiencies being linked to anemia.

2. Cellular Energy Generation
The copper dependent enzyme cytochrome c oxidase (CCO) plays an important role in cellular energy production within the mitochondria, as it catalyzes the reduction between molecular oxygen (O₂) to water (H₂O) creating the electron gradient required for ATP production. The redox-active copper contained within the enzyme is thereby necessary for the reaction and production of energy (ATP)

3. Connective Tissue and Cardiovascular Integrity
A different copper based enzyme (cuproenzyme), lysyl oxidase (LOX), is required for the cross-linking of collagen and elastin fibers, which is essential for the formation of strong and flexible connective tissue. LOX function is also critical for bone formation and the maintenance of connective tissue in the heart and blood vessels

4. Neurological Function and Myelination
Cuproenzyme tyrosinase, TYR, is necessary for the production of melanin in melanocytes to normal pigment of hair, skin, and eyes. Low TYR activity can explain achromotrichia in copper-deficient animals, and the depigmentation seen in copper-depleted Menkes disease patients.

5. Antioxidant Defense and Immunity:
Superoxide dismutase acts as an antioxidant by catalyzing the conversion of O₂⁻, -OH, and H₂O₂. These are reduced to water. There are two forms of copper-containing SOD containing copper: SOD1 is expressed in most cells and EcSOD which is highly expressed in the lungs and at lower levels in plasma.

6. Regulation of gene expression:

Copper-related gene expression pathways are mainly regulated at an after translation. This can be accomplished by protein trafficking mechanisms that respond to intracellular copper levels. Cytosolic copper can influence expression levels of certain mRNA genes. Intracellular copper may induce oxidative stress, activating pathways that increase the expression of genes that code for proteins involved in the detoxification of reactive oxygens.

HOW IT WORKS

Copper is taken into the body via diet. When foods containing copper are consumed the copper ions within are absorbed partially thru the stomach where the highly acidic environment frees the bound copper ions from partially digested food particles. While the large majority is absorbed in the small intestine, specifically when it passes into the duodenum and ileum, which are the major sites of absorption. As a result of complexing with amino acids, organic acids, or other chelators, a high fraction of copper is soluble in the intestinal tract. Where mucosal cells take it up via simple diffusion and transfer it via basolateral surfaces.

TOO MUCH/TOO LITTLE

Deficiency or toxicity outcomes

Causes of deficiencies- Conditions that affect absorption of copper known as mal-absorption Syndrome (Ex.Chron's, Celiac, IBS) Also caused by malnutrition. High levels of zinc can impair copper absorption.

Effects of deficiencies- Copper deficiencies can cause complications such as anemia, Osteoporosis, hyperlipidemia, neuropathy of the peripheral nervous system, and Neutropenia (low neutrophil counts).

FUN OR HISTORICAL FACTS

From 2000 B.C. and on, copper was often used for water purification and wound treatment.

In their 2008 study, MUSC microbiologists Hubert H. Attaway and Sarah E. Fairey lowered hospital-acquired infection rates by 58% by using copper.

FOOD SOURCES

Examples of foods ranked in copper concentrations

| | Vegetables | Fruits | Breads and Grains | Dairy | Proteins | Fats, Oils, Condiments | Sweets | Beverages |
|-------------------------------------|---|--------------------------------------|---|--|--|---------------------------------|--|---|
| low (< 0.08mg per serving) | Brussels sprouts, onions, mushrooms, olives, pickles | Apples, plums, oranges | White bread, oat cereals, rice cereals | Almond milk, dairy milk, cheese, non-dairy, ice cream, chocolate | Eggs, white meat, turkey, tuna, flounder | Butter, oil, soy sauce, ketchup | Jam, jelly, honey | Coffee, tea, fruit juices. |
| medium (0.08mg - 0.2mg per serving) | Artichokes, spinach, okra, squash, thyme | mangoes, blackberries, grapes, kiwis | Wheat bread, old fashioned oats, quinoa | Chocolate, almond milk, chocolate late dairy milk, cup, chocolate, late ice cream. | Canned Beans, peanut butter, beef, shrimp | Fresh pesto sauce | gummy bears (1.5oz), molasses (1 tbsp), milk chocolate candy (1.5oz) | prune/orange juice, grapefruit juice, pineapple juice (1 cup) |
| rich (> 0.2mg per serving) | Vegetable Juices, Lima Beans, Sweet Potato, and Potatoes w/ skin. | Dried Fruit (except cranberries) | Soy Flour, Soy Grits, Bran Cereals, and Corn Grain. | Soy Milk and Nutrition Shakes (ie. Soy Boost, Ensure, Carnation Breakfast Essential) | Dry Beans, Lentils, Nuts/Seeds, Tofu, Organ Meats, Duck, Lamb, Goose, Squid, Crab, and Shrimp. | N/A | Cocoa and Dark Chocolate | Mineral Water |



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Creatine

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NUTRIENT INTRODUCTION

Creatine is a naturally occurring compound made from the amino acids arginine, glycine, and methionine. It is produced mainly in the liver, kidneys, and pancreas. About 95% of the body's creatine is stored in skeletal muscle, with smaller amounts found in the brain and other tissues. It plays an important role in supporting the body's energy demands, particularly in muscle and nerve cells.

WHY IT'S IMPORTANT

- **Supports Brain Health:** Creatine is found in the brain and may help support cognitive processes that require rapid energy use, such as memory and concentration.
- **Improved Exercise Performance:** May increase the capacity for repeated high-intensity activity by helping the body sustain short bursts of effort and recover between them.

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HOW IT WORKS

Creatine is a natural compound that helps muscles regenerate ATP. Increasing phosphocreatine in muscle improves performance in short, high-intensity exercise like heavy lifts and sprinting. It also pulls water into muscle cells, which can make muscles look fuller and slightly increase body weight. ⁵

TOO MUCH/TOO LITTLE

Low creatine can cause developmental delay, speech problems, seizures, and movement issues, which could be treated with supplementation. Too much creatine is mainly discussed in the supplement context, where side effects include weight gain, an upset stomach, nausea, diarrhea, headache, and dehydration. ^{1,2,3}

FUN OR HISTORICAL FACTS

- Creatine was first discovered in 1832 by French chemist Michel Eugène Chevreul, who isolated it from skeletal muscle.
- The name *creatine* comes from the Greek word *kreas*, meaning "meat."
- The average adult stores about 120-140 grams of creatine in their body.

FOOD SOURCES

- Beef and other red meats
- Fish and seafood
- Poultry
- Milk, yogurt, and cheese in smaller amounts
- Concentrated powder or gummies⁴

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Cryptoxanthin

Did you know an orange can help build your bones and protect your body?



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Student Name: Mayur Ruppa

NUTRIENT INTRODUCTION

Beta-cryptoxanthin is a natural orange pigment found in fruits and vegetables. It belongs to a group of plant compounds called carotenoids, which give fruits like oranges their warm color.

The name comes from Greek "crypto" (hidden) and "xanthos" (yellow), meaning "hidden yellow." It is a provitamin A carotenoid, meaning the body can turn it directly into vitamin A. It is one of the top 5 most common carotenoids found in human blood, which shows the body holds onto and uses it regularly. [1]

WHY IT'S IMPORTANT

Vitamin A Production: Converted into vitamin A, needed for vision, immunity, and growth. [2]

Bone Strength: Stimulates bone-building cells and slows bone breakdown. Linked to lower fracture risk. [3]

Antioxidant Power: Neutralizes free radicals that damage cells, lowering risk of chronic disease. [2]

Reduces Inflammation: Higher intake is linked to lower risk of rheumatoid arthritis and other inflammatory diseases. Even one extra glass of OJ per day made a difference. [4]

HOW IT WORKS





- 1 You Eat It**
Beta-cryptoxanthin sits inside plant cells in foods like tangerines, papaya, and oranges.
- 2 Digestion Releases It**
Your stomach breaks down the food and releases the compound from the plant cells.
- 3 Absorbed with Fat**
The small intestine absorbs it best alongside a small amount of dietary fat (like nuts or avocado).
- 4 Liver Stores It**
It travels through blood to the liver, which stores it or sends it to body tissues.
- 5 Converted to Vitamin A**
Body enzymes break it into retinol (vitamin A) for use in vision, cell growth, and immunity. [2]

TOO MUCH / TOO LITTLE

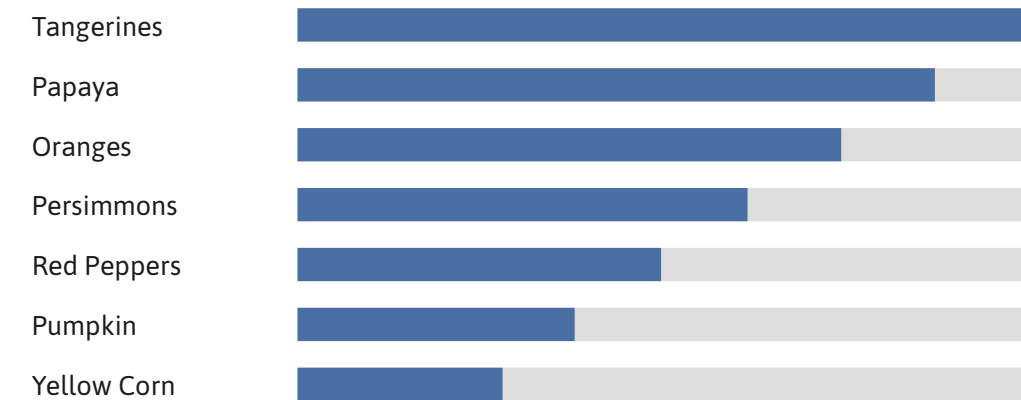
Too Little: No specific deficiency condition exists for beta-cryptoxanthin alone. However, low intake reduces vitamin A production, which can cause night blindness, weakened immunity, and bone loss over time. No toxicity has been found from eating whole foods. [1]

Too Much: Eating very large amounts from food may cause carotenoderma, a harmless condition where skin turns slightly yellowish. It goes away on its own. Very high-dose supplements are not recommended without a doctor's guidance. [1]

FUN OR HISTORICAL FACTS

-  Japan has done much of the key research on this nutrient because the Satsuma mandarin orange, popular in Japan, is one of the richest sources in the world.
-  Scientists first identified and named cryptoxanthin in the 1930s while studying pigments in egg yolks. The name "hidden yellow" came from how difficult it was to isolate.
-  Beta-cryptoxanthin is one of only 3 carotenoids the body can directly convert to vitamin A. The other two are alpha-carotene and beta-carotene.
-  Women who drank mandarin juice daily for months showed measurable improvements in bone health markers, just from the juice. [3]

FOOD SOURCES



Relative beta-cryptoxanthin content [1]

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VIP NRI Virtual Internship
Program UNC Nutrition Research
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Eicosapentaenoic Acid (EPA)

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NUTRIENT INTRODUCTION

- EPA stands for Eicosapentaenoic Acid.
- It is a 20-carbon long-chain omega-3 polyunsaturated fatty acid (PUFA).
- The human body cannot make enough EPA on its own because conversion from alpha-linolenic acid (ALA) is very limited.
- Therefore, EPA must be obtained primarily through diet.

WHY IT'S IMPORTANT

- EPA helps regulate inflammation.
- Supports heart and blood vessel health.
- Helps lower triglyceride levels.
- Research shows purified EPA can reduce the risk of heart attacks, strokes, and other major cardiovascular events by about 25%.

HOW IT WORKS

- After consumption, EPA is absorbed and incorporated into cell membranes.
- EPA changes membrane structure and fluidity.
- During injury or stress, EPA competes with arachidonic acid for COX and LOX enzymes.
- EPA produces anti-inflammatory compounds including series-3 prostaglandins, series-3 thromboxanes, and E-series resolvins.
- These compounds help reduce inflammation throughout the body.

TOO MUCH/TOO LITTLE

Too Little Results in:

- Increased inflammation.
- Reduced cardiovascular protection.
- May contribute to elevated triglyceride levels.

Too Much Results in:

- Very high supplemental doses may increase bleeding risk in some individuals.
- May cause stomach upset or fishy aftertaste.

FUN OR HISTORICAL FACTS

- EPA was first identified as one of the major beneficial fatty acids found in fish oil.
- Populations with high fish consumption have historically shown lower rates of heart disease.
- EPA is found naturally in marine algae, which is the original source of omega-3s in the ocean food chain.

FOOD SOURCES

- Salmon
- Sardines
- Mackerel
- Herring
- Anchovies
- Tuna
- Fish oil supplements
- Marine algae/algal oil

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Fluoride

A trace mineral found in water and dietary sources that is used in public health

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NUTRIENT INTRO & HISTORY

- **Enamel-Strengthening:** Fluoride promotes remineralization making the teeth more resistant to acid attacks from bacteria and sugar. (6)
- **Photochemical Synthesis:** Fluoride is a mineral that is naturally found in water, soil, and other foods. (6)
- **Colorado Brown Stain (1901):** Dentist McKay observed that Colorado Springs residents had unusually low rates of tooth decay but brown-stained teeth leading to fluoride research. (7)
- **Michigan Fluoride Breakthrough(1945):** Michigan became the first city to fluoride its water supply leading to a major public-health effort. (7)

WHY IT'S IMPORTANT

- 1 Safeguarding Enamel:** Fluoride strengthens the enamel by improving its resistance against acid attacks. (1)
- 2 Stopping Tooth Decay:** Fluoride prevents cavities by protecting teeth from the harmful impacts of bacteria and sugar. (1)
- 3 Repairing Early Damage:** The use of fluoride assists in replacing minerals that were previously lost from enamel before a cavity finishes developing.
- 4 Helps Long-Term:** By regularly being exposed to fluoride through multiple sources like water and dental products, healthy teeth are maintained throughout life.

CURRENT RESEARCH

Question: How does fluoride exposure in childhood affect cognitive health through adolescence and into adulthood (5)?

Summary: A cohort study was used to examine and compare cognitive test results from participants in secondary school and at the age of 60. This data was derived from the United States High School and Beyond cohort (5).

Findings: The study found that children who were exposed to the FDA recommended amount of fluoride showed better cognition in secondary school than their peers. However, as they aged, they did not have an advantage by the age of 60 (5).

HOW IT WORKS:

- Fluoride attaches to the tooth enamel and protects it from acid created by bacteria inside the mouth. (4)
- Fluoride slows and lessens the loss of calcium and phosphate in the enamel when acids try to dissolve the enamel layer, reducing demineralization. (4)
- To recoup the effects of demineralization, fluoride returns calcium and phosphate to the enamel, repairing damage and promoting remineralization. (4)
- Being exposed to fluoride reduces the effects of the acid produced by bacteria and lowers the risk of cavities.(4)

TOO MUCH / TOO LITTLE

DEFICIENCY

- **Dental Caries:** Carcinogenic bacteria ferment and make acids which dissolve tooth mineral (3).
- **Bone Fractures:** The absence of fluoride can lead to slower bone regeneration after a fracture (3).

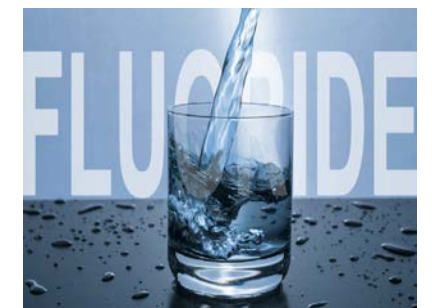
TOXICITY

- **Dental Fluorosis:** A cosmetic condition where teeth are stained with white or brown lines at a young age (2).
- **Skeletal Fluorosis:** A rare condition where bone loss occurs when consumption exceeds 2mg/L (2).

FOOD SOURCES

While Fluoride is most commonly obtained through dental products, it is found in trace amounts in some foods (2).

- Brewed black tea and coffee
- Fluoridated water
- Shellfish
- Oatmeal
- Potatoes
- Raisins



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Folate (Vitamin B9)

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NUTRIENT INTRODUCTION

Vitamin B9, also known as folate, is a **water-soluble** vitamin that must come from the diet or through supplementation because the human body does not make any folate on its own. The name folate is derived from the Latin term folium, which means "leaf", since folate was discovered first in spinach. Its formal chemical name is **pteroylglutamic acid**. Folate is found naturally in foods, while "folic acid" is the synthetic form that is added to supplements and to fortified cereal grains. The daily recommended amount of folate for adults is 400 mcg of dietary folate equivalents (DFE) and 600 mcg during pregnancy. In 2023, folate ranked as the 94th most frequently prescribed medication in the USA, with more than 7 million prescriptions written for this supplement.

WHY IT'S IMPORTANT

Folate is an important part of DNA synthesis, DNA repair, and cell division. Its importance increases during periods of rapid growth (the time of pregnancy, infancy, and adolescence). One of the most recognized benefits of folate is in the prevention of neural tube defects (NTDs) such as spina bifida and anencephaly; studies have shown that taking folic acid leads to a 69% reduction in the risk of having an NTD (RR of 0.31). Additionally, folate is essential for supporting one-carbon metabolism in combination with vitamin B12; together they create methionine from homocysteine. Because of the link between low levels of folate and elevated levels of homocysteine, homocysteine is an independent risk factor for a person developing cardiovascular disease. Folate is also needed for the production of red blood cells. Without folate, the red blood cells will become very large and not work correctly (this condition is called megaloblastic anemia). Recent studies have begun to find an association between folate, DNA methylation, and epigenetic regulation; this suggests that the nutritional status of folate (especially during pregnancy) may affect how genes are expressed in the offspring and influence the risk of developing metabolic disease for generations.

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HOW IT WORKS

Folate in food comes as a multitudes of glutamate units (polyglutamate) and must be converted to single glutamate form (monoglutamate) through the action of intestinal enzymes to be absorbed. Synthetic forms of folic acid are absorbed almost twice as well as folate from food (approximately 85% versus approximately 50%). Once absorbed, folate is converted to dihydrofolate (DHF) and then tetrahydrofolate (THF) in the liver through the action of the enzyme dihydrofolate reductase. All carbon transfer reactions involved in folate metabolism depend on the reaction between THF and an amino acid (serine) that forms an activated form called 5-methyltetrahydrofolate (5-MTHF). By providing carbon to make DNA and RNA and for other reactions where methyl is added to DNA to regulate gene expression, 5-MTHF is critical for all one-carbon metabolism. In addition, 5-MTHF is used to remethylate homocysteine back to methionine, thus maintaining normal homocysteine concentrations.

TOO MUCH/TOO LITTLE

A 100% deficiency leads to megaloblastic anemia (the formation of extremely large red blood cells), high levels of homocyst(e)ine (which are a sign of increased cardiovascular risk), reduced energy levels, and painful sores inside your mouth (oral ulcers). Having too little vitamin B12 during pregnancy creates a significantly greater probability of defect in developing the baby's neural tube (such as spina bifida). The groups that have the highest risk of developing these problems are pregnant women, heavy drinkers, those who have celiac disease, and those who are carriers of an MTHFR gene polymorphism.

According to current guidelines, daily intake of synthetic folic acid should not exceed 1,000 mcg/day. Supplemental levels greater than this will obscure a diagnosis of Vitamin B 12 deficiency which leads to undiagnosed anemia; thus allowing potentially substantial damage from Vitamin B 12 related neurologic disorders to publicly flourish/verily exist. Another concern is that excess amounts of supplemental (or fortification with) folic acid may increase the rate of pre-existing colonic malignancy development; however the research on supplementation versus fortification regarding this endpoint is limited and mixed.

FUN OR HISTORICAL FACTS

Folate is the only one among the thirteen essential vitamins that a woman has discovered. British scientist Lucy Wills went to Bombay (present-day Mumbai), India, in 1931 to research why pregnant women who worked in textile factories were dying from severe anaemia. She found that giving them yeast extract (Marmite) would help fix their problem. It was called the "Wills factor" for nearly ten years until Mitchell, Snell and Williams isolated what is now known as folic acid from four tons of spinach leaves in 1941 and gave it the name of folic acid, which comes from the Latin word "folium," which means leaf. The first antibacterial medications (sulfonamides) and first anticancer medications (methotrexate) were designed to act as antifolates - medicines that stop folate metabolism so that quickly dividing bacteria or cancer cells are killed. Since 1998, the United States requires that all enriched grain products be fortified with folic acid, resulting in a decrease in the rate of neural tube defects (NTD) being born by approximately 50% to 70%.

FOOD SOURCES



Folate

Folate and Folic Acid (B-9)

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Student Name: Harinee Jibeesh

NUTRIENT INTRODUCTION

The discovery of folate began in the 1930s when British hematologist Lucy Wills identified an unknown nutritional factor in yeast and liver that was utilized for treating anemia in pregnant women and monkeys. This unidentified compound became known as "Wills' factor," a name later given by Janet Watson and William B. Castle, which was a form of folate [4]. This new vitamin then was crystallized, chemically identified, and synthesized as pteroylglutamic acid and named folic acid between 1943 and 1945.

Folate, also known as folacin or vitamin B-9, is a water soluble molecule that can be naturally present, added, or utilized as a dietary supplement. Folate also commonly appears in fortified foods (products with excess vitamins/minerals to prevent deficiencies), such as folic acid.

WHY IT'S IMPORTANT

Folate helps the body make red blood cells, produce cell growth, and synthesize DNA.

Pregnancy and fetal development are the stages where it is most critical that one intakes a lot of folate. It has past records showing how it prevented birth defects called neural tube defects. This is because folate helps that neural tube develop which directly influences how the brain and spine develop. This is why it is critical that women get 400 micro-grams of folic acid before and during early pregnancy to help prevent NTDs [2].

Folate also aids in preventing heart and blood vessel diseases and strokes. Working along with vitamins B-6 and B-12, Folate controls homocysteine levels which can detrimentally raise risk for cardiovascular disease.

HOW IT WORKS

Folate has three main functions. It breaks down the food folates which are initially polyglutamates, into a single mono-glutamate form. This digestion usually occurs in the gut.

The new mono-glutamate is then absorbed in the small intestine due to a Proton-Coupled Folate Transporter (PCFT) [1].

The folate then becomes metabolized into 5-methyltetrahydrofolate (5-MTHF). It then enters the bloodstream and travels to the liver [1].

In order to aid in cell growth and repair, folate transfers carbon molecules to help with the building blocks of DNA, building proteins, and forming red blood cells.

EXCESSIVE/DEFICIENCY

Especially in America, people are usually able to consume a healthy amount of folate, but when they don't, it turns into something called folate deficiency. Getting too little folate can cause megaloblastic anemia - a blood disorder causing heart palpitations, fatigue, etc. Folate deficiency also causes open sores around and in the mouth.

However, intaking too much folate also results in detrimental health risks. High doses of folate increase the risk of colorectal cancer and other cancers. Alongside that, it hides a B-12 deficiency because folate corrects anemia that B-12 causes, but not the nerve damage. So that deficiency can then cause damage to the brain, spinal cord and nerves without you even knowing.

RESEARCH/FUN FACTS

Current research centering around Folate is its effect on colorectal cancer and adenoma. The NIH-AARP Diet and Health Study performed a study showing that individuals (>525,000) from the ages 50-71 in the US, who had around 900 mcg/day of folate intake had a 30% lower risk of colorectal cancer than those who took < 200 mcg/day [1]. This demonstrates associations between high dietary folate intakes and risk for colorectal adenoma and cancer.

- 130 New York babies have neural tube defects annually. Nationally, there are 4,000 NTD-affected pregnancies annually
- A glass of orange juice and a bowl of fortified cereal provides 50-100% of the recommended daily amount of folic acid.
- Folic acid can only help prevent NTDs during the first weeks of pregnancy, before even knowing you're pregnant. [5]

FOOD SOURCES/INTAKE

Humans usually end up absorbing more folic acid from it being fortified foods and dietary supplements in comparison to folate from foods.

Table 1: Recommended Dietary Allowances (RDAs) for Folate [2]

| Age | Male | Female | Pregnancy | Lactation |
|--------------------|-------------|-------------|-------------|-------------|
| Birth to 6 months* | 65 mcg DFE* | 65 mcg DFE* | | |
| 7-12 months* | 80 mcg DFE* | 80 mcg DFE* | | |
| 1-3 years | 150 mcg DFE | 150 mcg DFE | | |
| 4-8 years | 200 mcg DFE | 200 mcg DFE | | |
| 9-13 years | 300 mcg DFE | 300 mcg DFE | | |
| 14-18 years | 400 mcg DFE | 400 mcg DFE | 600 mcg DFE | 500 mcg DFE |
| 19+ years | 400 mcg DFE | 400 mcg DFE | 600 mcg DFE | 500 mcg DFE |

Folate is found mainly in dark green leafy vegetables, beans, peas and nuts. Fruits rich in folate include oranges, bananas, melons and papayas [3].

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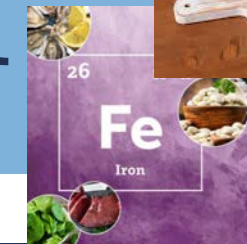
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Iron: The Energy Mineral



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Student Name: Diya Chivukula



NUTRIENT INTRODUCTION

Iron is an essential nutrient that helps our bodies produce energy, and it is involved in carrying oxygen throughout our bodies. Our bodies do not produce iron on its own, therefore, iron must be consumed through our diets. There are two types of iron we consume: heme iron and non-heme iron. Heme iron, which is considered much more bioavailable, is exclusively found within meat (red meat, poultry) and the absorption rate is anywhere between 15%-35%. Non-heme iron is found in plant-based foods, dairy, grains, and animal products. It has an absorption rate anywhere between 2%-20%. Iron is a building block of hemoglobin, which is a protein found in red blood cells. It is responsible for carrying oxygen from the lungs to tissues within our bodies. Iron is highly dynamic, with its other roles including serving as a co-factor for several mitochondrial enzymes that generate ATP. Furthermore, because it aids in synthesizing neurotransmitters (ex: dopamine, serotonin, norepinephrine/epinephrine), it is a crucial ingredient in proper neurological and cognitive development.

Iron has been used for centuries, with medicinal uses, specifically treating chlorosis, dating back to the 17th century. Chlorosis, once called "Green Sickness" is today known as iron-deficiency anemia. Iron's name stems from Proto-Germanic and Proto-Celtic roots. The word iron itself stems from the Anglo-Saxon word *iren*, translating directly to "the metal iron". Its chemical symbol is Fe, located in group 8, period 4 on the periodic table. It is a transition metal, with its chemical symbol coming from the Latin word "ferrum".

WHY IT'S IMPORTANT

Iron, one of nine trace minerals, is crucial in oxygen transport within our bodies. On average, 3 to 4 grams of iron can be found in an individual's body. 70% of those grams can be discovered within red blood cells, while around 25% can be discovered within a protein called ferritin. Ferritin can be found within the liver, the spleen, bone marrow, and muscle tissue. Iron is a major component of heme, an essential building block of hemoglobin. Hemoglobin, as elaborated previously, is a protein within our red blood cells that carries oxygen from our lungs into all of our cells. It furthermore carries the waste gas produced by our cells, carbon dioxide (CO₂), back into our lungs. This is the reason we are able to breathe out currently. Therefore, when iron becomes insufficient, there isn't enough hemoglobin, meaning oxygen is no longer being transported and our cells are incapable of performing their specialized roles. Myoglobin is a protein that stores oxygen within our skeletal muscles and heart muscle cells. It as well becomes affected when iron is deficient. Other bodily functions that rely on iron include cell reproduction and ATP synthesis. Each cell is dependent on oxygen and ATP production, so DNA synthesis, cell division, muscle contraction, and other homeostasis-maintaining systems become inhibited. Iron absorption can be aided by Vitamin C, Citric Acid, and Vitamin A. Each of these help with absorbing and releasing stored iron. Following the recommended daily intake (8 mg for men, 18 mg for women who undergo a regular menstrual cycle, and 27 mg for pregnant women) is crucial, because many consume foods that are potential Iron inhibitors daily, including phytate, calcium, and polyphenols. It is also crucial because 10% of women have iron deficiency anemia, and 35% of women of reproductive age are deficient in iron (10% for men).

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HOW IT WORKS

Iron is a vital component during many metabolic processes in the body, such as electron transport, DNA synthesis, and when transporting oxygen throughout the body. Iron is only stored in the body through absorption, making it a mineral that is prone to a deficiency of. There are 2 types of dietary iron that is absorbed; Non-Heme Iron and Heme Iron. Heme Iron originates from the myoglobin and the hemoglobin of animal foods, such as poultry, meat, red meat and seafood. Non-heme Iron originates from plants and supplemental iron infused food products, which are not as well absorbed as Heme Iron since it is in the ferric form. Iron absorption occurs in the intestines and the Duodenal Cytochrome B (DcytB) converts ferric iron into ferrous iron. Iron is then transported into the intestine cells through a protein call Divalent Metal Tansporter 1 (DMT1). Afterwards, the Iron leaves the intestines through the Ferroportin order to enter the bloodstream. Lastly, as the iron exits with the ad of Ferroportin, either the caeruloplasmin in the blood or the Hephaestin the intestine converts the ferrous iron into the ferric form so it is able to bind to Transferrin, which distributes iron throughout the bloodstream.

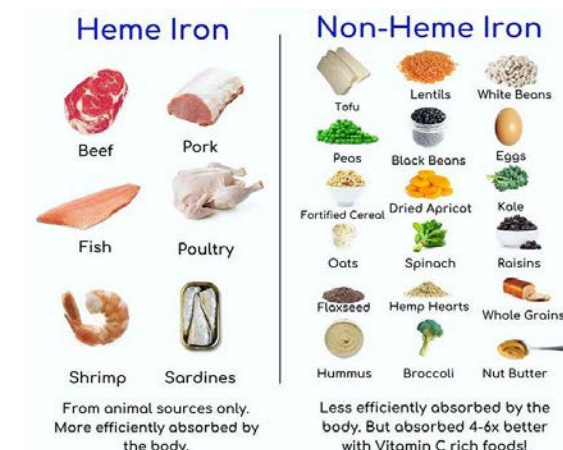
TOO MUCH/TOO LITTLE

There are a multitude of effects that can occur as a result of unregulated iron levels. Hemochromatosis is a condition where there is an excess amount of iron. When a large amount of iron is consumed, it is stored in the organs since there isn't a direct way to remove iron from the body. When there isn't enough iron within the body, a condition known as iron deficiency (otherwise known as Anemia) occurs. This results in the blood lacking enough red blood cells (or hemoglobin) to distribute oxygen throughout the body. Iron is regulated in a specific way, but overconsumption of iron supplements or genetic conditions can cause iron poisoning or toxicity, leading to the obstruction of internal organs, that can lead to permanent damage.

FUN OR HISTORICAL FACTS

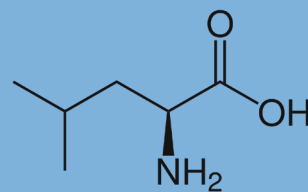
- Iron is 1 of 9 trace minerals required to be on a nutrition label by the Food and Drug Administration, because of how much of a nation-wide health concern anemia is.
- Iron has been associated with the health of living things for hundreds of years, but we didn't understand why until 1932 (the inorganic-organic paradox).
- 10% of women have iron-deficiency anemia, while just under 2% of men do. This disparity stems from the fact that women lose iron during menstruation, and pregnant women must support oxygen delivery not just to themselves, but to their developing baby.
- Most trace minerals are excreted from our bodies via our gastrointestinal tract, but there is no regulated excretion pathway for Iron. Iron instead is conserved, reabsorbed, and recycled due to the aid of hepcidin, a hormone that regulates Iron homeostasis.

FOOD SOURCES



VIRTUAL INTERNSHIP PROGRAM
UNC NUTRITION RESEARCH INSTITUTE

Leucine



The amino acid that helps your muscles grow and recover.

Student Name: Sejal Pandey

Student Name: Ivy Datta

NUTRIENT INTRODUCTION

Leucine is an essential amino acid, meaning the body cannot produce it on its own and it must be obtained from food. It is also one of the branched-chain amino acids (BCAAs) along with isoleucine and valine.

Amino acids like leucine are the building blocks of proteins, which are necessary for many functions in the body, especially growth and repair.



WHY IT'S IMPORTANT

Leucine is important because it helps with many key body functions. Some of them are:

- Muscle growth and strength by promoting protein synthesis
- Regulating blood sugar levels by supporting glucose uptake and insulin function
- Wound healing and tissue repair, since it supports the formation of new tissue

It is especially important for athletes, older adults, and anyone trying to maintain muscle mass.

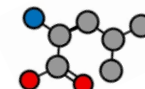
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HOW IT WORKS

After consuming protein-containing foods, leucine is absorbed and used by the body to support protein metabolism. It plays a role in stimulating muscle protein synthesis, which is the process of building new muscle proteins.

Leucine also contributes to energy metabolism. This means it can be broken down and used as a source of energy, especially during exercise or times of increased demand.



TOO MUCH/TOO LITTLE

Too little leucine:

Since leucine is needed for protein synthesis, not getting enough can lead to reduced muscle mass, slower recovery, and lower overall physical performance.

Too much leucine:

Very high intake, especially from supplements, can lead to imbalances with other amino acids and may affect normal metabolism if it's not taken properly.



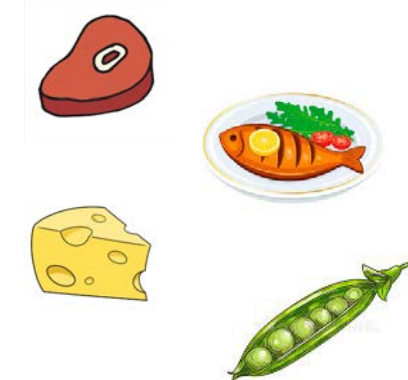
FUN OR HISTORICAL FACTS

- Leucine was first discovered in cheese in 1819, making it one of the earliest amino acids scientists identified.
- It is the most abundant branched-chain amino acid.
- Leucine is linked to a rare condition called maple syrup urine disease, where the body cannot properly break down certain amino acids.
- Leucine is used by many different parts of the body, including the liver, muscles, and even the brain.

FOOD SOURCES

Leucine is found in many protein-rich foods. Some examples are:

- Meat (beef, pork, chicken, turkey)
- Fish (such as tuna and salmon)
- Dairy products (cheese, milk)
- Beans and legumes
- Nuts and seeds



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Lutein and zeaxanthin

The "Why" for your Eye

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Student Name: Alexandra Eusebio

NUTRIENT INTRODUCTION

Lutein and zeaxanthin are two different nutrients, but naturally coexist and work together. They are antioxidant carotenoids, meaning they are fat-soluble pigments found in plants that when consumed, neutralize free radicals, preventing cell damage. They are isomers; they have the same formula but a different arrangements of atoms in the molecules. In the human body, they are especially important for eye, heart, and skin health.

WHY IT'S IMPORTANT

Lutein and zeaxanthin are very important for organ function, including the eye, skin, heart, and intestines. These nutrients are present in the macula and the lens, which are tissues of the eye. The pigments prevent oxidative processes from occurring when the retina is exposed to light. These oxidative processes can lead to disease, such as heart disease, and possibly cancer. Preventing macular degeneration is important because the degeneration of the macula, the central part of the retina, allows for sharp, straight vision. They also improve vision by increasing the contrast, making objects easier to differentiate from their backgrounds.

HOW IT WORKS

Because lutein and zeaxanthin are fat-soluble, they require dietary fat for absorption in the small intestine. They are then packaged into chylomicrons and carried through the lymphatic system into the bloodstream, where lipoproteins (LDL and HDL) transport them to tissues. The body selectively deposits them in the retina and lens of the eye, as well as in the skin and brain. Any excess is stored in fatty tissue or metabolized by the liver.

TOO MUCH/TOO LITTLE

Too little: Low intake is linked to a higher risk of age related macular degeneration (AMD), cataracts, and progressive vision loss. Because these pigments filter blue light and neutralize free radicals in the retina, a deficiency leaves the eye more vulnerable to oxidative damage. Skin may also become more vulnerable to UV damage.

Too much: No toxic upper limit has been established, and these nutrients are considered safe even at high intakes. Very high, long-term consumption may cause carotenodermia which is a harmless yellowing of the skin that reverses once intake is reduced.

FUN OR HISTORICAL FACTS

Lutein and zeaxanthin are the only two carotenoids found in the human retina and lens, earning them the nickname "macular pigments." The human body cannot produce them on its own they must come entirely from food or supplements. Lutein was first isolated from marigold flower petals in the early 1800s, while zeaxanthin was first identified in corn. Despite spinach having the highest amounts, egg yolks are one of the most bioavailable sources because the fat content boosts absorption. They are also what give corn and egg yolks their characteristic yellow color.

FOOD SOURCES



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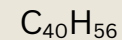
Nutrition Research: Lycopene

The Red Pigment Behind Powerful Health Benefits



1. What is Lycopene?

Lycopene, composed solely of carbon and hydrogen, is a naturally occurring plant nutrient that gives red and pink fruits their vibrant color. It's a powerful antioxidant protecting our bodies from cellular damage caused by free radicals, which are linked to chronic illnesses. It's known to support heart and skin health and may help prevent certain types of cancer. [1,2,6]



2. Where Can We Find It?

Lycopene is a red pigment (carotenoid) found mainly in red and pink fruits and vegetables. Tomatoes and tomato products like sauce, paste, and ketchup provide the majority of lycopene in the typical American diet – often over 80%. Other strong sources include watermelon, pink grapefruit, guava, papaya, and red bell peppers. [4] Processed or cooked tomato foods usually give more absorbable lycopene because heat breaks down cell walls. [3] Pairing these foods with a bit of healthy fat (like olive oil) helps your body take it in better.

3. How Much Do We Need?

There is no official recommendation for daily intake, since it's not considered an essential nutrient. However, studies and experts suggest 10 mg to 30 mg per day to experience antioxidant and heart-health-supporting benefits. Your body best absorbs it when it's cooked, processed, or eaten with a little healthy fat.

Consuming high amounts of lycopene from natural food sources is completely safe. [2,4,5]

4. How Does the Body Use Lycopene?

When you eat lycopene-rich foods, digestion releases it from the plant matrix in the stomach and small intestine. As a fat-soluble nutrient, it absorbs best with dietary fats and gets packaged into chylomicrons for transport via the lymphatic system into the blood. [1] It then builds up in tissues like the liver, skin, prostate, and adrenal glands. Lycopene works mainly as an antioxidant, neutralizing free radicals and cutting oxidative stress. [3] It may also affect cell signaling related to inflammation. Unlike some carotenoids, it can't turn into vitamin A, but it still supports cellular health.

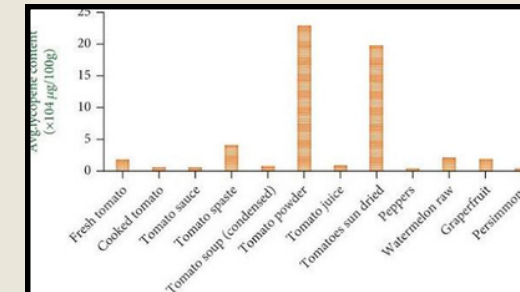
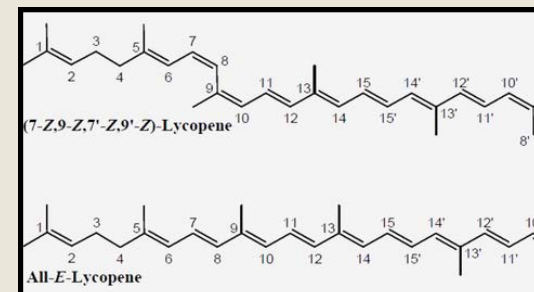
6. Key Takeaways

Lycopene is a powerful phytonutrient best known from tomatoes and other red produce. Its antioxidant effects help fight free radical damage that contributes to aging and disease. [2,6] Studies link higher intake to potential benefits for heart health, skin protection from UV, and prostate health. [5] While more research is needed on exact mechanisms and supplements, evidence strongly supports getting lycopene from whole foods as part of a balanced diet for long-term wellness. Including it regularly is an easy way to boost nutrition. [1,3]



5. Significance

Lycopene is significant because it's an antioxidant pigment with importance in neutralizing free radicals, lowering oxidative stress, and helping protect the body from chronic conditions such as heart disease, cognitive decline, and certain cancers. [2,3,1]



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SOHNI PATHAN
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MAGNESIUM

INTRODUCTION

Magnesium is a major dietary mineral, and the human body contains about 25 grams of it overall. More than half is stored in bones, while the rest is found in soft tissues and body fluids [1]. It is an essential mineral your body needs for hundreds of enzyme-driven processes, including energy production, muscle and nerve function, protein synthesis, and maintaining strong bones. It is naturally present in many foods, especially leafy green vegetables, nuts, beans, whole grains, and seeds [2]. The word magnesium comes from Magnesia, an ancient region in Thessaly, Greece, where related minerals were first found. The name was later adopted in modern chemistry and standardized for the element by Humphry Davy. Its deeper root is the Greek place name Magnesia, which also gave rise to words related to magnet and manganese [3].

Digestion: Having low levels of blood magnesium can make the gut lining weaker and increase the inflammation. Magnesium might help improve digestive diseases like Celiac, Crohn's, ulcerative colitis, Inflammatory bowel disease (IBD) which means their digestive tract absorbs less magnesium and excessive loss through diarrhea so supplements could help them. Magnesium can help treat indigestion and heartburn by neutralizing extra stomach acid. Magnesium helps with constipation by pulling water into the intestines to increase water content and amount of stool. Although magnesium does help with constipation, it does not help with diarrhea and in fact is a common side effect if too much is consumed. [12]

Absorption: In older adults, absorption of magnesium from the gut is decreased and excretion of renal magnesium increases alongside their age. Magnesium absorption happens mainly in the ileum and distal parts of the jejunum, and smaller portions are transported in the large intestine. Absorption happens mainly via intercellular diffusion and solvent drag methods. There is some absorption in the small intestine and descending colon which is important during times of low magnesium intakes. 27-76% of magnesium that is ingested is absorbed through the gut and the rest is excreted via stool. 95% of the magnesium excreted is reabsorbed through the loop of Henle (65%) and distal tubes (30%) Pharmacy doses of vitamin D can help increase the absorption of magnesium within those who have vitamin D deficiency. [10,11]

Metabolism: Magnesium metabolism happens through the intestines where absorption happens, bones where storage occurs, and the kidneys for excretion. Diet (12 mmol) goes into the intestine that puts out 6mmol of total intestinal absorption towards the extracellular fluid and 2 mmol enters from digestive juices. 84 mmol is then filtered into the kidneys where 80 mmol is reabsorbed into the extracellular fluid and 4 mmol is excreted through urine. The extracellular fluid is a hub area which connects the kidneys, tissues, and intestines. Bone and soft tissue is where magnesium has exchange with the extracellular fluid keeps the system levels maintained. [13,14]

IMPORTANCE

- Magnesium helps with muscle and nerve function, energy production, protein synthesis, blood sugar control, blood pressure regulation, bone health, and DNA repair. It also helps the body use vitamin D and calcium properly
- It also supports heart, nerve, muscle, and bone health. Low intake or deficiency is linked with fatigue, weakness, cramps, abnormal heart rhythm, and higher risk of problems like high blood pressure, diabetes, osteoporosis, and migraines [4].
- Conditions commonly associated with low magnesium include hypomagnesemia, hypertension, heart disease, stroke, type 2 diabetes, osteoporosis, migraines, and in severe cases seizures or arrhythmias [5].

HOW IT WORKS

FUN/HISTORICAL FACTS

- Only in 1930s was magnesium recognized as an essential nutrient in everyday diet [6].
- Magnesium deficiency in humans was first described in 1951, which is relatively recent in the history of nutrition science The name "magnesium" comes from Magnesia, a region in ancient Greece, and Epsom salts became famous in England in the 1600s for their laxative effect [1].
- About 60% of the magnesium in the human body is stored in bones Magnesium was found by Sir Humphrey Davy in 1808 In plants, magnesium sits at the center of chlorophyll, which is why leafy green vegetables are such classic magnesium-rich foods In plants, magnesium sits at the center of chlorophyll, which is why leafy green vegetables are such classic magnesium-rich foods. [6].

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FOOD SOURCES



TOO MUCH/LITTLE

Deficiency: insufficient amounts of magnesium in a humans blood is known as hypomagnesemia. Magnesiums affects cellular or nerve functions withing the brain, muscles, and heart aswell as managing the balance of sodium, calcium, and potassium so it can be seen happening alongside hypokalemia (low potassium levels) and hypocalcemia (low blood calcium levels). Hypomagnesemia can is caused by three factors: Intestines do not absorb magnesium from food eaten, bones are unable to store magnesium, or kidneys not properly excreting the magnesium (too much). Symptoms include: nystagmus (unusual eye movement), arrythmia, tetany, tremors, fatigue, and weakness. [15]

Toxicity: excessive amounts of magnesium in the blood is known as hypermagnesemia. This can be observed in people with kidney failure and take medications containing magnesium. Some symptoms include: confusion, nausea, dizziness, and weakness. A few of the causes are: adrenal insufficiency, hemolysis, hypothyroidism, hypercalcemia, addisons disease, or injury from trauma. [16]

OVERVIEW & CORE ROLES

Phosphorus is a vital chemical element (Symbol: P, Atomic Number: 15). An adequate amount of phosphorus allows for the foundation for strong bones, genetic material, and energy production. It is essential for processes regulating nerve signaling, muscle contractions, and blood pH levels.

BONES & TEETH

85% of the body's phosphorus is stored in bones and teeth. It is combined with calcium to form strong bone mineral crystals—known as **hydroxyapatite**. It is essential for bone growth and maintenance throughout life, and it helps keep teeth healthy and resistant to decay. Low phosphorus levels can cause weak bones and dental problems.

ENERGY & ATP

Phosphorus is a key component of ATP (adenosine triphosphate), the body's energy molecule, which provides the body with energy. ATP stores and transfers energy for cellular activities. Every muscle contraction needs ATP and phosphorus. It helps the body utilize carbohydrates and fats for energy, and supports the metabolism of carbohydrates, fats, and proteins. Without phosphorus, cells cannot produce energy efficiently.

GENETICS & GROWTH

Phosphorus is a structural component of DNA and forms part of the phosphate backbone of genetic material. It is also found in RNA, which helps make proteins for growth and repair. It is essential for cell growth, division, repair, and helps transmit genetic information to the next generation.

DIETARY RECOMMENDATIONS & FOOD SOURCES

RECOMMENDED DIETARY ALLOWANCES (RDA)

| | |
|-------------------------|----------|
| Adult males and females | 700 mg |
| Teens and preteens | 1,250 mg |

DIETARY SOURCES

| |
|--|
| DAIRY PRODUCTS Yogurt, milk, and cheese. |
| ANIMAL PRODUCTS Many types of fish, ham, chicken, egg, deer, and ribeye. |
| PLANT-BASED PRODUCTS Sunflower seeds, pumpkin seeds, squash seeds, black beans, almonds, brown rice, peanuts, soybeans, barley flour, whole wheat bread, lentils, etc. |

CLINICAL CONDITIONS: DEFICIENCY & TOXICITY

1 HYPERPHOSPHATEMIA (EXCESS PHOSPHORUS)

- Definition:** Higher than 4.5 mg/dL in adults. Excess phosphorus can lead to hyperphosphatemia.
- Risk Factors:** Extremely common in people with chronic kidney disease or kidney failure. In healthy individuals, excess phosphorus is usually removed by healthy kidneys, but long-term excess can weaken bones, increase cardiovascular risk, and increase PTH (Parathyroid hormone) levels.
- Complications:** Can remove calcium in the bones and blood, leading to hypocalcemia.
- Symptoms:** Muscle cramps, brittle nails, dry skin, coarse hair, memory problems, mood swings, paresthesia (tingling in lips, tongue, fingers), seizures, and abnormal heart rhythms (arrhythmia).
- Treatment:** Medicine to lower phosphate levels, cutting back on phosphorus-rich foods, or dialysis.

2 HYPOPHOSPHATEMIA (PHOSPHORUS DEFICIENCY)

- Definition:** Below 2.5 mg/dL in adults. Phosphorus deficiency causes hypophosphatemia.
- Risk Factors:** Severe hypophosphatemia is commonly found in people with alcohol-use disorders, burns, severe infectious (sepsis), or diabetes-related ketoacidosis.
- Symptoms:** Muscle and bone pain, muscle weakness, respiratory or heart failure, numbness/weak reflexes, seizures, and altered mental states.
- Complications:** Can lead to osteomalacia (soft bones prone to fracture), or even coma or death if not treated.
- Treatment:** Primarily consists of phosphate replacement in the form of pills or an IV, depending on the severity. It is also vital to consume foods high in phosphorus.

HYPOPHOSPHATEMIA IN REFEEDING SYNDROME

New research suggests that rapid recovery from malnourishment can lead to hypophosphatemia as a result of refeeding syndrome.

Refeeding syndrome occurs when a malnourished individual begins feeding again. As the body attempts to metabolize nutrients again, severe electrolyte deficiencies can occur. During refeeding, the body's phosphorus levels are significantly depleted in order to sustain metabolic activity, which can lead to hypophosphatemia.

HISTORICAL CONTEXT:

This result of refeeding syndrome was historically seen in World War II, in which famished Japanese prisoners were provided with food and unexpectedly became ill. It was reported that approximately 1/5th of the individuals died after nutritional and vitamin replenishment.

HISTORY, SCIENCE & FUN FACTS

| | | | | |
|---|--|---|---|---|
| THE NAME Derived from Greek Mythology, meaning "God of morning star". | NATURAL ALLOTROPES Exists as white, red, and yellow phosphorus in the Earth's crust. | WHITE PHOSPHORUS Can glow when exposed to oxygen (phosphorescence). | RED PHOSPHORUS Used in matchsticks. | THE DISCOVERY Isolated by German alchemist Hennig Brand in an accidental discovery. Brand believed that since human urine was yellow, it might be a way to create gold. He boiled down human urine into a thick paste and heated it at extremely high temperatures. Instead of gold, it turned into a waxy substance that glowed in the dark and burst into flames when exposed to air. |
|---|--|---|---|---|

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POTASSIUM

Student Name: Preeth Viswanathan

Student Name: Kalyn Maldonado

NUTRIENT INTRODUCTION

Potassium is a necessity for the normal functioning of all cells in the human body. It regulates our heartbeat, and balances out the negative effects of sodium. Potassium also lowers stroke risk, and can lower high blood pressure. It also plays a vital role in synthesizing proteins and metabolizing carbohydrates. It can also help with transmitting nerve signals to your brain, it transmits nerve signals that your muscles need in order to contract. This prevents dry, achy and cramped up muscles.

Potassium is also an electrolyte, which means it diffuses into ions or charged particles in liquids, and capable of electricity.

WHY IT'S IMPORTANT

- As an intracellular cation, it affects cell's concentration gradient across membranes to facilitate "nerve transmission, muscle contraction, and kidney function."³
- Correlation between high potassium intake and increased bone mineral density & decreased blood pressure (excess sodium flushed)
- Low potassium intake can also affect calcium re-absorption from calcium reuptake which can lead to hypercalciuria (high calcium in urine)

HOW IT WORKS

Body converts food and drinks into energy, keeping these processes balanced is called homeostasis.

-> How it works: Potassium is absorbed through passive diffusion, primarily in the small intestine.³ About 90% of potassium ingested is absorbed and used to maintain sodium levels and its normal intracellular and extracellular concentrations.³

->Excretion: Potassium is excreted in urine, and some from the stool. The kidneys control the excretion in response to changes in dietary intakes, and increases rapidly in healthy people after potassium consumption.

TOO MUCH/TOO LITTLE

Hyperkalemia is too much potassium, which is very unlikely.

-> High potassium can usually be excreted for those with normal kidney function.

-> It can lead to heart abnormalities/arrhythmias, paralysis, or death for those with renal dysfunction.

Low potassium is called hypokalemia, which can occur due to eating disorders, excessive sweating, or bowel/adrenal conditions, etc.²

-> It leads to hypertension, kidney stones, bones losing mineral density, salt sensitivity.³

FUN OR HISTORICAL FACTS

1. Potassium was first isolated in 2907 by Humphry Davy using electricity to separate it from potash.
2. Nearly 98% of the human body's potassium is found inside cells.
3. Potassium is extremely reactive, that pure potassium metal can burst into flames when exposed to water!
4. Potassium is the seventh most abundant element in Earth's crust.
5. If you could see potassium burning, it produces a lilac-purple flame which is often used to identify it in chemistry labs.

FOOD SOURCES

Potassium is only obtainable through supplements or your diet!³ Below are some sources:^{2,3}

- Almonds
- Apricots
- Avocados
- Bananas
- Cashews
- Leafy Greens
- Flaxseeds
- Lentils
- Oranges
- Potatoes
- Squash
- White beans

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Riboflavin

How do gut microbial communities influence riboflavin-related metabolic pathways?

Student Name: Anna Monaco

Student Name: Nevinka Lenora

NUTRIENT INTRODUCTION

- Riboflavin (vitamin B2) is a water-soluble vitamin
- It forms two coenzymes called FMN and FAD
- The large intestine produces free riboflavin through gut bacteria.
- Riboflavin is yellow and fluorescent under UV light.

TOO MUCH/TOO LITTLE

- It is assessed through EGRAC (erythrocyte glutathione reductase activity coefficient) and 24-hour urinary excretion.
- Both extremes can lead to serious health complications

GUT MICROBIOME ANALYSIS

Figure 1. Relative Abundance of Bacteroidetes, Fusobacteria, and Proteobacteria Across Five Gut Microbiome Samples

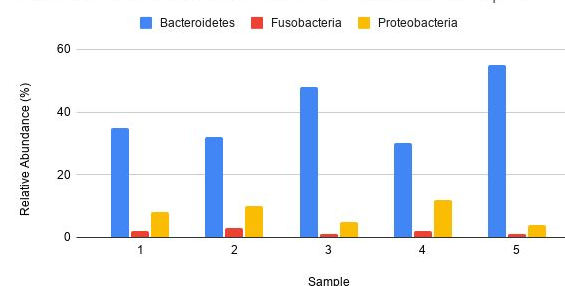
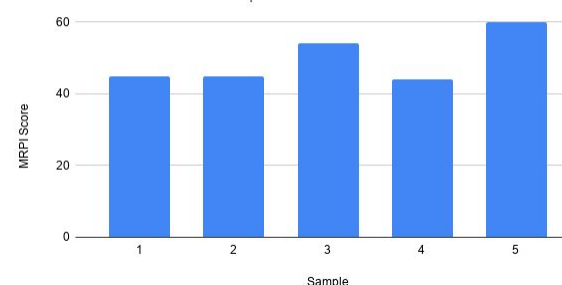


Figure 2. Microbial Riboflavin Potential Index (MRPI) Across Five Gut Microbiome Samples



Five gut microbiome samples were analyzed to compare the abundance of Bacteroidetes, Fusobacteria, and Proteobacteria. A Microbial Riboflavin Potential Index (MRPI) was calculated for each sample. Results demonstrated variation in bacterial abundance across samples, with Sample 5 exhibiting the highest MRPI score. These findings suggest differences in microbial communities associated with riboflavin-related metabolic pathways.

HOW IT WORKS

- Riboflavin causes cellular redox reactions
- Riboflavin is the building block the body uses to make the two molecules FMN and FAD.

FOOD SOURCES

- Riboflavin is found in meat, some nuts, green vegetables.
 - For example: Dairy milk, yogurt, cheese, eggs, lean beef, pork, organ meats, chicken breast, salmon, fortified cereal, bread, almonds, and spinach.

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SELENIUM

Main Question: How do dietary selenium levels vary across foods, and how close are they to the safe upper intake limit?

INTRODUCTION

Selenium is a mineral that the body needs in small amounts to stay healthy. It helps the body make special proteins that are important for thyroid function, reproduction, DNA production, and protecting cells from damage and infections.

DIGESTION/METABOLISM

Selenium is absorbed in the small intestine after you eat it. The body uses it to make important proteins and stores small amounts in different tissues, but it does not store large amounts like some vitamins.

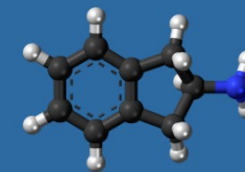
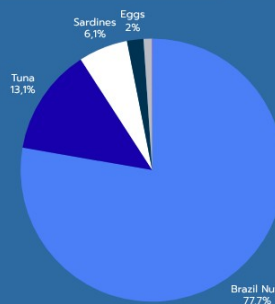
WHY IT'S IMPORTANT

Selenium is important because it helps protect the body's cells from damage, supports a healthy thyroid, strengthens the immune system, and may help keep the brain healthy as people age.

FOOD SOURCES

Different foods contain different amounts of selenium:

- Brazil nuts contain the highest amounts.
- Seafood such as tuna and sardines are excellent sources.
- Eggs and dairy products provide moderate amounts.
- Grains and vegetables usually contain the lowest amounts.



SPECIFIC FOOD EXAMPLES

Brazil Nuts

- Brazil nuts contain the most selenium of any common food.
- Eating just one Brazil nut can provide more selenium than your body needs for a whole day.

Seafood

- Seafood is one of the best sources of selenium.
- Foods like tuna and sardines contain high amounts and can help you meet your daily needs.

Eggs and Dairy

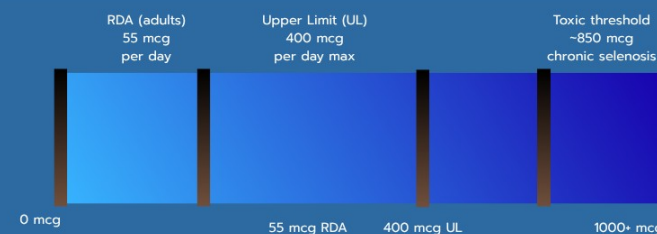
- Eggs, milk, yogurt, and cheese provide moderate amounts of selenium.
- They help contribute to your daily selenium intake.

Grains and Vegetables

- Grains and vegetables usually contain smaller amounts of selenium.
- The amount depends on how much selenium is present in the soil where the plants are grown.

TOO MUCH TOO LITTLE

Selenium is one of the few nutrients for which deficiency and excess intake can cause serious diseases. The gap between them is very minimal.



DEFICIENCY EFFECTS

- Keshan Disease - fatal cardiomyopathy (heart enlargement and cardiac shock)
- Kashin-Beck Disease - cartilage/joint degeneration
- Immune dysfunction, increased infection risk
- Reduced thyroid hormone conversion
- Fatigue, muscle weakness, cognitive fog



SELENOSIS (EXCESS) EFFECTS

- Hair loss/brittle nails
- Garlic breath odor (volatile dimethylselenide)
- Nausea, diarrhea, skin rashes
- Neurological symptoms: tremors, dizziness, irritability
- Extreme doses can cause kidney/heart failure and can be potentially fatal

Sodium: The Essential Electrolyte

Student Name: Romy Parekh

Student Name: Ronit Gupta

NUTRIENT INTRODUCTION¹

- Sodium (Na⁺) is an essential mineral and electrolyte
 - The primary cation in extracellular fluid
- Its symbol Na comes from the Latin Natrium, and the name from the Arabic word suda (headache remedy using sodium carbonate)
- Body's main osmotic solute, essential for fluid balance, nerve impulse transmission, and muscle contraction

WHY IT'S IMPORTANT²

- Critical for:
 - fluid balance - maintains blood volume and cell hydration
 - nerve function - generates action potentials for brain and nerve signaling
 - muscle contraction (including the heart)
 - nutrient absorption - glucose and amino acids co-transport with sodium in the gut
 - blood pressure regulation - FDA recommends less than 2,300 mg/day for adults, WHO says less than 2,000 mg/day
 - Most Americans consume ~3,400 mg/day

HOW IT WORKS³

- Sodium is absorbed in the small intestine via sodium-glucose cotransport (SGLT) and Na⁺/H⁺ exchange
- The kidneys regulate sodium: when levels are high, more is excreted in urine; when low, kidneys retain it
- Aldosterone (steroid hormone) and ADH control sodium retention
- The sodium/potassium pump is like a tiny door in your cells. It moves sodium out and potassium in to help the cell stay balanced. This balance helps your nerves send messages and helps your muscles move.
- Normal blood sodium: 135-145 mmol/L

TOO MUCH/TOO LITTLE⁴

- TOO MUCH (Hypernatremia - Na⁺ >145 mmol/L): Causes high blood pressure (hypertension), increased risk of heart disease, stroke, kidney disease, osteoporosis, and gastric cancer
 - Sodium attracts water into the bloodstream, raising blood volume and pressure
- TOO LITTLE (Hyponatremia - Na⁺ <135 mmol/L): Causes brain swelling, nausea, confusion, seizures, and in severe cases, coma or death
 - Particularly dangerous in older adults and athletes who over-hydrate

FUN OR HISTORICAL FACTS⁵

- Salt can be traced back to ancient Egypt, when it was used for religious offerings and to preserve mummies
 - It was also a traded good between the Phoenicians and their Mediterranean empire
- The word "salary" derives from the Latin word "sal(t)" because Roman soldiers were sometimes paid in salt
- In old Japanese theaters, salt was sprinkled on the stage before each performance to prevent evil spirits from casting a spell on the actors

FOOD SOURCES⁶



cheese



table salt



snack foods (pretzels, chips)



soy sauce

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VIRTUAL INTERNSHIP PROGRAM
UNC NUTRITION RESEARCH INSTITUTE

Vitamin B-6

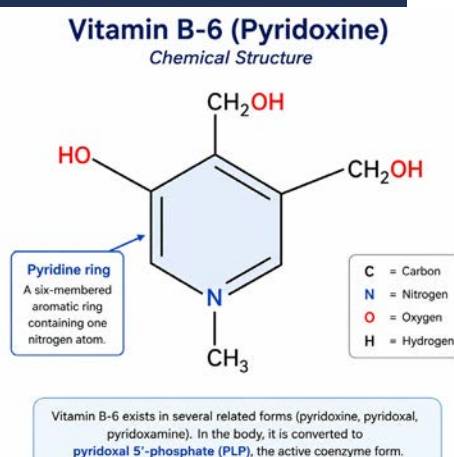
The Multitasking Vitamin

Student Name: Vedika Javeri

Student Name: Vishwa Reddy

NUTRIENT INTRODUCTION VJ

Vitamin B-6 is a dissolvable vitamin that helps the body use proteins, carbohydrates, and fats. It occurs in several forms such as pyridoxine, pyridoxal, and pyridoxamine. The name "pyridoxine" comes from its chemical structure, which contains a pyridine ring.



WHY IT'S IMPORTANT VR

Research supports that Vitamin B-6 decreases the risk of heart and blood vessel diseases. Vitamin B-6 is also associated with a higher cognitive function in older adults. Although there is limited clinical trials, a decrease Vitamin B-6 intakes may increase the likelihood of developing cancer. Evidence also suggests that Vitamin B-6 decreases the symptoms of premenstrual syndrome, and pregnancy nausea and vomiting.

HOW IT WORKS VR

Vitamin B-6 goes through a complex process of digestion, absorption, and metabolism in the human body which begins in the small intestines. Vitamin B-6 which naturally is found in a non-free phosphorylated form needs to be broken down into its free form. The free form of the vitamin can then travel to the jejunum for absorption into the bloodstream, which it travels through bound to albumin in the plasma. When Vitamin B-6 travels to the liver, it gets phosphorylated to its original form, and acts as a key cofactor for many critical enzymes.

TOO MUCH/TOO LITTLE VJ

Deficiency

- Fatigue
- Anemia
- Depression
- Weak Immunity
- Skin Inflammation

Toxicity

- Nerve damage
- Loss of coordination
- Numbness

FUN OR HISTORICAL FACTS VJ

1. Vitamin B-6 was discovered by Paul György in 1934 while researching on acrodynia (dietary skin disease).
2. Scientists have found 6 related compounds that make up the vitamin B-6 family.
3. More than 100 enzymes react due to this nutrient, making it one of the most versatile vitamin in the human body.

FOOD SOURCES VJ



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VIRTUAL INTERNSHIP PROGRAM
UNC NUTRITION RESEARCH INSTITUTE

Vitamin B12

Understanding the Blueprint and Biological Power of Vitamin B12

Student Name: Charvi Bhardwaj

Student Name: Janani Nallasura

NUTRIENT INTRODUCTION

What is it? Is there a meaning behind the name?

Vitamin B12 is an essential water-soluble vitamin that the human body requires for survival but cannot synthesize on its own. It holds a unique position among vitamins because it is produced exclusively by microorganisms and bacteria. The "B" indicates it is part of the B-complex group of water-soluble vitamins, while the "12" reflects it was the 12th uniquely identified nutrient in that specific series.

WHY IT'S IMPORTANT

Role in the body, health effects, related conditions

Vitamin B12 operates as a mandatory helper molecule for enzymes that manage fundamental cellular tasks. It is required for the synthesis of DNA during cell division and assists in converting fats and proteins into usable cellular energy which ensures rapid brain-to-body communication.

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HOW IT WORKS

Brief explanation of digestion/absorption/metabolism

Vitamin B12 is released from food in the stomach which is then bonded intrinsically. Then it is absorbed between the small and large intestine, where active cobalamin forms help DNA synthesis, fatty acid metabolism, red blood cell formation, and myelin maintenance.

TOO MUCH/TOO LITTLE

Deficiency or toxicity outcomes

Deficiency can cause megaloblastic anemia, which halts normal red blood cell development, causing them to grow abnormally large and fragile. As well as fatigue, glossitis, numbness, neuropathy, cognitive changes, and irreversible nerve damage if missed. There is no known tolerable upper intake limit because high intake has not shown consistent harm in healthy people

FUN OR HISTORICAL FACTS

Fun or historical facts

While most vitamins are colorless or faintly yellow, pure Vitamin B12 stands out because it naturally forms deep, ruby-red crystals. This vivid pigmentation is a direct optical result of the central cobalt atom bonding within the molecule.

FOOD SOURCES

Images or a list of food sources

- clams,
- beef liver,
- fish,
- meat,
- poultry,
- eggs,
- milk,
- yogurt,
- cheese,
- fortified cereals,
- fortified plant milks,
- and nutritional yeast.



Vitamin C

Student Name: Megan Henderson

Student Name: Aashi Rachhadia

NUTRIENT INTRODUCTION

Function: Vitamin C (ascorbic acid) is a nutrient your body needs to stay healthy

- Supports your immune system
- Makes collagen, a protein that skin, bones, blood vessels, and tissues need
- Heal wounds
- Helps absorb iron from foods
- Acts as an antioxidant to protect cells from damage

The name does not have a special meaning however early scientists discovered vitamins one by one and labeled them with letters on the alphabet .

WHY IT'S IMPORTANT

Human Body & Health Effects

- Vitamin C is also called an ascorbic acid
- Humans are unable to make vitamin C endogenously
 - making it essential to get from diet
- Vitamin C is necessary for synthesizing collagen
 - skin, bones, connective tissue

Potential Benefits

- AMD (age related macular degeneration) and cataract progression may be slowed from vitamin C along with other nutrients.
- Research suggests that the antioxidant properties of Vitamin C may help to lower risk of cardiovascular disease.

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HOW IT WORKS

Digestion

- Vitamin C is a water-soluble vitamin that requires little digestion, is released from food, and remains largely unchanged before absorption. Its main digestive role is helping the body absorb iron more efficiently.

Absorption

- Vitamin C is absorbed in the small intestine by specialized transport proteins (SVCTs), then carried through the bloodstream to body tissues.

Metabolism

- Vitamin C is distributed to many tissues, with high concentrations found in the adrenal glands, brain, and immune cells.

TOO MUCH/TOO LITTLE

- Too much can lead to hemochromatosis
 - excess iron in the body, damaging organs or tissues
- Too little can lead to scurvy and even anemia
 - compromises energy levels, internal structure, causing internal bleeding
 - prevents the body from producing collagen
- An adult should get around 75-90 mg of vitamin C per day
 - one orange provides this

FUN OR HISTORICAL FACTS

- Intaking more vitamin C helped defeat scurvy, which was a disease cause by Vitamin C deficiency.
- Vitamin C was one of the first vitamin isolated: In the early 1930s, Albert Szent-Györgyi isolated vitamin C and helped determine its structure. His work earned him the 1937 Nobel Prize in Physiology or Medicine.
- Humans do not make their own vitamin C however most mammals make their own vitamin C through the liver.

FOOD SOURCES



Citrus Fruits

- oranges, grapefruit (and their juices), red pepper, green pepper and kiwifruit

Other fruits and vegetables

- broccoli, strawberries, cantaloupe, baked potatoes, and tomatoes
- Some foods and beverages that are fortified with vitamin C

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VIRTUAL INTERNSHIP PROGRAM
UNC NUTRITION RESEARCH INSTITUTE

Vitamin D: The Sunshine Nutrient



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NUTRIENT INTRODUCTION

- Vitamin D is needed to regulate calcium and to maintain a healthy skeleton. Humans can obtain vitamin D from sunlight exposure, supplements, and foods, such as fatty fish, egg yolks, and fortified milk.
- Vitamin D is a fat-soluble nutrient that plays a vital role in maintaining overall health, and it is unique because the body can produce it when exposed to sunlight.
- Vitamin D supports bone health, immune system function, normal cell growth and muscle strength!

WHY IT'S IMPORTANT

Vitamin D serves many different functions, but the most prominent and researched one is calcium/phosphorous regulation. Calcitriol, the active form, gets released into an intestinal erythrocyte, where it binds to an VDR-RXR transcription complex to regulate certain genes. There, it increases the transcription and translation of certain Ca/P pumps and Calbindin, an intracellular transport protein, thus boosting absorption rates overall. Calcitriol can also regulate certain immune responses. For instance, it induces cathelicidin, a peptide with antimicrobial functions and suppresses inflammatory cytokines. Calcitriol also inhibits cell proliferation and stimulates differentiation, playing a role in cancer.

HOW IT WORKS

- Because Vitamin D is a fat soluble vitamin, it is absorbed along with dietary fats in the small intestine. When foods containing Vitamin D are eaten, it is mixed with fats and absorbed through the intestinal wall,
- It can also be produced by the skin when exposed to UVB rays. In this process, a cholesterol-derived compound in the skin is converted into vitamin D3.
- After absorption or production, vitamin D is transported into the liver and kidneys, transforming into different forms. One of these forms, calcitriol, acts as a hormone and regulates calcium and phosphorus levels in body.

TOO MUCH/TOO LITTLE

Vitamin D deficiency is defined by **<20 ng/mL** and insufficiency is defined by **<30 ng/mL** by the PES. Chronic deficiency can lead to rickets in children and osteomalacia/osteoporosis in adults. Calcitriol is regulated by PTH through a negative feedback loop. If there is chronic hypocalcemia due to low Vitamin D, then PTH will over promote phosphate secretion and bone resorption.

Vitamin D toxicity is usually defined by levels **>150 ng/mL** and leads to hypercalcemic conditions, which can manifest symptoms such as organ calcification, over expression of certain deleterious genes, and kidney stones. However, toxicity is rare.

FUN FACTS & RESEARCH

- Vitamin D was the fourth nutrient ever found: hence its name, the fourth letter of the alphabet. Most people, without knowing it, are actually vitamin D deficient! Around 70% of Americans.
- Vitamin D isn't really a vitamin, but rather a hormone.
- Current and recent research regarding vitamin D actually includes the differences in absorption and metabolism between the different kinds, which includes Vitamin D2, Vitamin D3, and 25 hydroxy-vitamin D.

FOOD SOURCES

Vitamin D does not have much bioavailability, and the human body endogenously synthesizes 80-90% of our DV, with supplementations for deficient people.

Foods rich in Vitamin D include: Cod liver oil, farmed cooked trout, mushrooms (exposed to UV light after harvest), fortified milk (all types), fortified cereal.

Foods rich with ergosterol (mushrooms, fungi) must be exposed to UV light to transform into D2, but this is usually less potent than foods with dehydrocholesterol (D3).

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Vitamin E

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NUTRIENT INTRODUCTION

Vitamin E is a fat-soluble vitamin that acts like a powerful antioxidant for the body by protecting the body's cells from damage caused by free radicals. This protection is essential because cellular damage can contribute to aging and development of diseases. In addition, Vitamin E also supports immune system functions, your skin's visual health (aging) and your vision/eye health .

WHY IT'S IMPORTANT

Vitamin E is important for vision, the brain, blood, and skin. It helps fight diseases and maintain healthy eyesight. As an antioxidant, it works to protect cell membranes from oxidative damage and fight against free radicals (unstable molecules that damage cells). Beyond its antioxidant properties, it also supports cellular communication by enabling cells to carry out metabolic processes. Vitamin E can also help maintain the skin barrier when used in a topical moisturizer.

HOW IT WORKS

1. Vitamin E is consumed through foods like nuts, seeds, vegetable oils, spinach, avocado and other dark leafy vegetables.
2. It's then absorbed in the small intestine with other dietary fats.
3. Vitamin E is transported through the bloodstream to tissues in the body.
4. Vitamin E neutralizes harmful free radicals which protect cell membranes.
5. This supports the immune systems function and promotes healthy skin and eye health.
6. Extra vitamin E is stored in the liver and fatty tissues to be used in the future.

TOO MUCH/TOO LITTLE

Too little: can worsen eyesight, causing [retinopathy](#) (damage to the retina). It can also cause [neuropathy](#) (nerve pain).
Too much: Can cause major bleeding events, including intracranial hemorrhage. It's also been studied that taking Vitamin E by mouth may raise the risk of prostate cancer. It should be noted that it is very difficult to reach toxic levels of Vitamin E to have these drastic negative impacts (one would have to ingest around 1,000 mg).

FUN OR HISTORICAL FACTS

- Vitamin E was discovered by scientists Herbert McLean Evans and Katharine Scott Bishop in 1922.
- It's use was found necessary for reproduction purposes when testing was done on laboratory animals, this gave it the nickname "fertility vitamin."
- One of the richest natural food sources of vitamin E is almonds.
- Vitamin E is commonly seen used in skincare products because of its antioxidant properties that help protect the skin cells from environmental damages including the sun.

FOOD SOURCES

Most people are able to receive the recommended daily amount of Vitamin E (15 mg) through a balanced diet. Vitamin E is found in leafy greens (spinach, broccoli, etc.), as well as vegetable oils (sunflower, corn, safflower), and nuts (almonds, peanuts, hazelnuts). Consuming Vitamin E through food sources alone is not risky, and there is no risk of overdose of Vitamin E through food sources alone.

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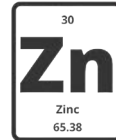
Zinc: The Silent Catalyst of Our Health

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NUTRIENT INTRODUCTION

Most people don't realize that zinc acts as a catalytic cofactor and helps over 300 enzymes power the chemical reactions that keep us alive. Zinc is an essential trace mineral that is found in every cell of the body, but it cannot be produced or stored, which makes a regular dietary intake necessary. It supports DNA synthesis, protein production, metabolism, immune function, growth, and wound healing. The name "zinc" is believed to come from the German word "Zinke," which means "point" or "tooth," which refers to the pointed crystals formed by zinc metal.



WHY IT'S IMPORTANT

Zinc acts as your body's repair technician by protecting, rebuilding, and supporting almost every organ system, and it does this through the following:

- Boosts immune function by supporting infection-fighting cells.
- Essential for DNA synthesis, protein production, and cell growth.
- Promotes wound healing and tissue repair.
- Supports healthy skin, hair, nails, and normal growth.
- Maintains taste and smell.



HOW IT WORKS

Every bite of zinc starts a very controlled journey through your body. Firstly, Zinc is released from food during digestion in the stomach and small intestine and is absorbed mainly in the jejunum. Zinc from animal-based foods is absorbed more easily, while compounds called phytates in whole grains and legumes can reduce absorption. Once in the bloodstream, zinc attaches to albumin, a protein that carries it to cells and organs throughout the body. Because the body cannot store much zinc, it must be consumed regularly through a diet.

TOO MUCH/TOO LITTLE

Acute Toxicity Symptoms:

- Nausea and vomiting
- Watery or bloody diarrhea
- Headaches and dizziness

Chronic Toxicity Symptoms:

- Copper deficiency
- Anemia
- Neurological issues

Risk Factors:

- Impaired renal function
- Over-supplementation

A 2024 review titled *Zinc Toxicity: Understanding the Limits* found that excessive zinc intake can cause copper deficiency by interfering with copper absorption. Researchers reported that this can lead to anemia, weakened immune function, and neurological complications.

Deficiency Symptoms:

- Alopecia, rashes, acne, brittle nails
- Frequent Infections, slow wound healing
- Unexplained weight loss, poor appetite

Risk Factors:

- Vegetarians and vegans
- Gastrointestinal disorders

In 2025, a meta-analysis found that COVID-19 infected patients with zinc deficiency had a greater risk of mortality and symptomatic disease than individuals without zinc deficiency. Scientists have not yet proven that the deficiency itself caused those worse outcomes. Observational studies have been done by the Hospital del Mar Research Institute in Barcelona, while the meta-analysis was led by Raval and his colleagues in Florida.

FUN OR HISTORICAL FACTS

- India was producing zinc centuries before Europe could.
- Zinc can affect your sense of taste and smell.
- Zinc is found in hundreds of enzymes in your body.
- Some crops are being bred to contain more zinc.
- Many pennies contain zinc.
- Zinc may influence memory and learning.



FOOD SOURCES

Serving Size/Zinc Content in Milligrams



90 grams/15 mg



100 grams/6 mg



100 grams/3 mg



120 grams/3 mg



30 grams/2 mg

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