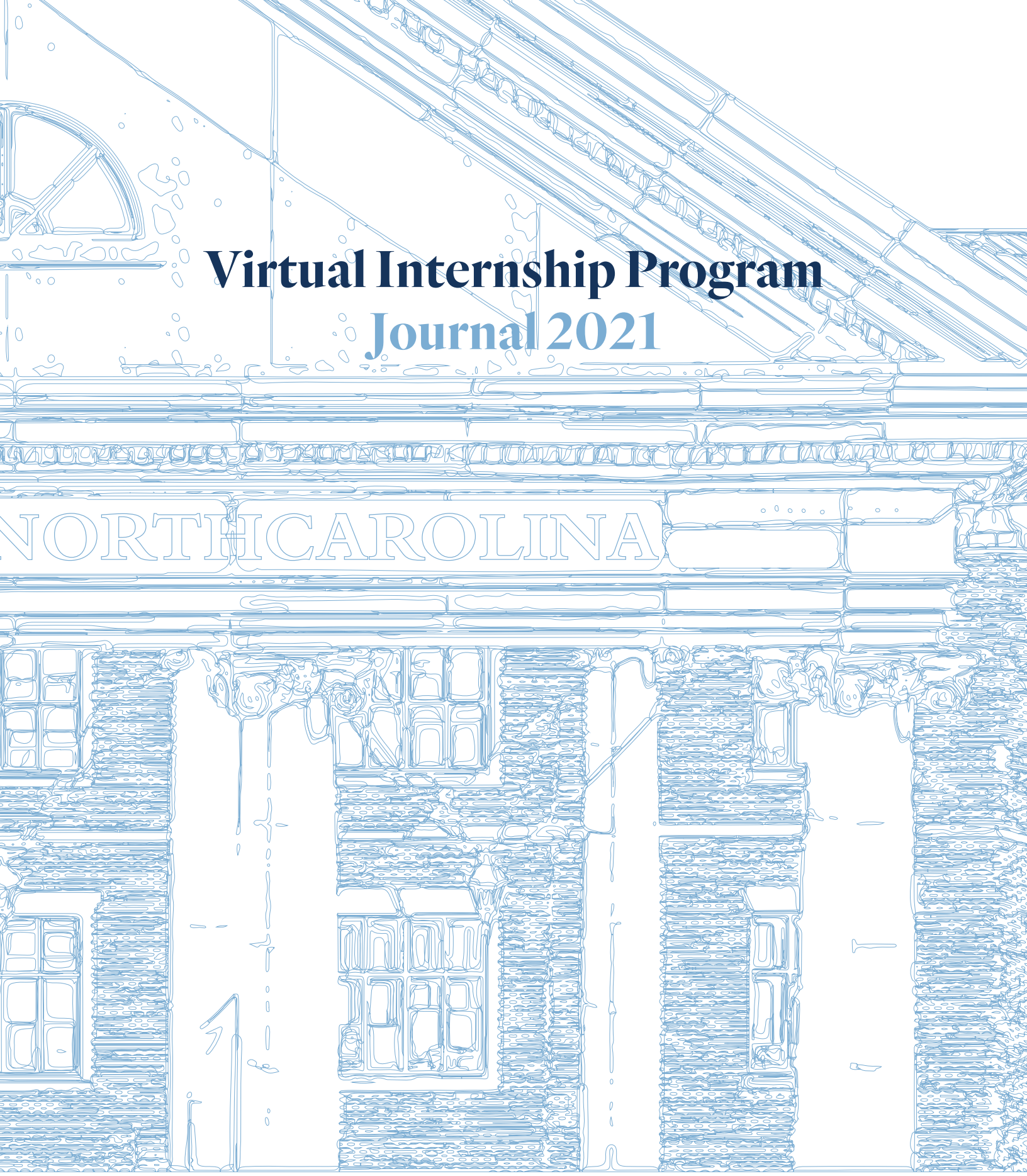

Virtual Internship Program

Journal 2021

UNC | NUTRITION RESEARCH INSTITUTE

Nutrition Research Institute
University of North Carolina at Chapel Hill

Virtual Internship Program

Journal 2021

Edited by
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UNC | NUTRITION RESEARCH INSTITUTE

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Letter from the Editor

At the UNC Nutrition Research Institute (NRI), we regularly welcome interns into our labs, allowing students the opportunity to work alongside our faculty scientists, post-doctoral researchers, graduate students, and laboratory staff. The COVID-19 pandemic forced our team to cancel all in person activities for summer 2020, including our internship program. We quickly pivoted to a virtual model to offer a first of its kind program at the NRI: a Virtual Internship Program (VIP) for high school students.

The 2020 Virtual Internship Program was such a success that we began recruiting for a second class of students in Spring 2021 and were delighted to welcome an even larger group of students in Summer 2021 than in our inaugural year. The 2021 program ran for six weeks and offered weekly lectures and group mentoring sessions via Zoom. Over the course of these six weeks each student was also expected to complete an independent research paper on the nutrient of their choice. During our concluding session, students presented their research to an audience of their peers, family members, lecturers, and mentors. The caliber of work presented was exceptional. Class of 2021, we are incredibly proud of your hard work and dedication and wish you all the best in your future endeavors!

Student papers have been lightly edited but remain the original work of our dedicated high-school interns.

Our program would not have been possible without the support of our lecturers, mentors, and administrative staff. Special thanks to:

Keri Barron, PhD
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Discovery

About the NRI

A leader in the Precision Nutrition space, the NRI is developing and applying cutting-edge methods to determine why metabolism and nutrition requirements differ between individuals.

We seek to understand nutrient metabolism and its relationship to human development and disease with the goal of increasingly replacing general dietary guidance with more customized nutrition recommendations.

Nutrigenetics

Identifying the genetic blueprint that makes each of us respond uniquely to nutrition and what it means for our personal health.

Epigenetics

Studying chemical marks on genes that turn them on or off, and are often affected by nutrition early and for the rest of life.

Nutrigenomics

Using molecular tools to understand how nutrients may affect the expression of genes.

Metabolomics

Measuring thousands of small molecules (metabolites) to better understand how nutrition affects our metabolism, performance and health.

Microbiomics

Studying how each of the many microbe species in our gut affects our nutritional health in different ways and makes us respond uniquely to nutrition.

We do precision nutrition.

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Caffeine and Its Impact on Pregnancy

Have you ever been dragging early in the morning, barely able to function and in need of some sort of pick-me-up? Well, most people will turn to coffee or tea for an early morning lift in energy because it contains a nutrient called caffeine, scientifically is referred to as methyltheobromine or methylxanthine. The following contents will discuss the basic understandings behind caffeine, and more specifically how it relates to pregnancy and the effects on newborns.

Historical Insight & Context

Sources of caffeine have been used to fuel our bodies since the early indigenous tribes in the Americas and in ancient China. Indigenous tribes used to break down leaves and stems of various plants to make several kinds of herbal teas. Similarly, but more famously, China has always been known for its usage and production of tea from at least 2,000 years ago in the Han dynasty. It even had a religious purpose amongst the monks of many Buddhist temples, which "proved to keep the monks awake during long hours of meditation" ("The History of Tea"). However, the nutrient behind this phenomenon would not be identified until 1819 by a chemist named Friedlieb Ferdinand Runge. This discovery would help lead to the invention of synthetic caffeine and the creation of many popular drinks and food items today.

Importance of Caffeine

Function & Daily Intake

The main function of caffeine is to "stimulate the central nervous system" and other parts of the body such as the heart and various muscles ("Caffeine"). As a psychoactive drug, meaning that it can change mood, behavior, and thinking, caffeine can "increase the body's state of arousal by speeding up the production of nerve impulses, which increases the activity of

the brain" ("Caffeine: The Facts"). In order to prevent the effects of fatigue and sleepiness, caffeine will block adenosine, a chemical in the body that makes you tired, "resulting in an energy boost or heightened alertness"("Caffeine: America's Most Popular Drug").

Although the body doesn't inherently need caffeine to sustain homeostasis, it can be utilized when needed. It is recommended that the maximum daily intake for adults is 400mg and young adolescents "need to be cautioned about excessive caffeine intake and mixing caffeine with alcohol and other drugs" (Mayo Clinic Staff). Along with this, pregnant women are advised to not exceed 200mg daily.

Impacts of Caffeine on the Body

Caffeine acts in a similar way to amphetamines, cocaine, and heroin because it stimulates the brain, but is much milder. However, it still has "addictive qualities" ("Caffeine: America's Most Popular Drug"). Like most nutrients, caffeine can have different effects in individuals, and some can be more prone to them than others. As previously mentioned, the body does not need caffeine to survive, which means that if an individual chooses not to consume it, they will not see any adverse reactions or effects. However, if too much caffeine is consumed for that particular individual, it can have negative impacts. For example, if a moderately healthy adult chooses to exceed the daily recommended intake of 400mg, they can expect to experience short-term complications such as "restlessness and shakiness, insomnia, headaches,

dizziness, abnormal heart rate, dehydration, anxiety, and dependency" ("Caffeine"). In some cases of over-consumption, death can also be a potential side effect, but it is very uncommon. Those consuming food or drinks containing caffeine should be aware and read the labels to ensure they are not exceeding the daily intake.

Metabolism of Caffeine

The process of metabolizing caffeine is much quicker than one would expect. When consumed orally, "99% of caffeine ingested is absorbed within 45 minutes" (Nehlig). Due to caffeine's inability to be broken down by stomach acids, it distributes to the rest of the body, even to reproductive organs. This is why women who are pregnant must limit caffeine intake, as the baby cannot metabolize caffeine as sufficiently due to their developing organs.

Once fully ingested, cytochrome P450 enzymes coded for the CYP1A2 gene and found in the liver are responsible for breaking down the caffeine. CYP enzymes are typically found in the endoplasmic reticulum and mitochondria of the liver, used in protein synthesis and processing adenosine triphosphate (ATP). This step of metabolism is important because "CYP1A2 is responsible for more than 95% of the primary metabolism of caffeine", which controls the rate at which the nutrient is broken down (Thorn et al.). Finally, the body will expel the broken down nutrients through urination. The body does not store the nutrient for further use, but the effects of caffeine can last for several hours afterwards. Like most functions in the body, the rate at which caffeine is metabolized is dependent on the condition of the individual. Those who smoke, are pregnant, take certain medications, have liver disease, etc., will likely see varying rates compared to a healthy adult.

Sources of Caffeine

Caffeine can be found naturally in 60 different plant species, "of which cocoa beans, kola nuts, tea leaves and coffee beans are the most well-known" ("Sources of Caffeine-Coffee and Health"). However, caffeine is also synthetically produced, but has the same chemical make-up as naturally occurring caffeine. The only distinguishable difference is how they are derived; synthetic caffeine being produced from urea and chloroacetic acid, "rather than extracted from plant products like natural caffeine" (Hu). Despite the little difference between the two types, there has been research done to prove the benefits of caffeine. With that being said, the FDA organizes caffeine into "five categories" (Hu):

- Foods: chocolate (cacao), guarana (a seed from a South American plant), peanut butter, candy, etc.
- Beverages: tea, coffee or espresso, chocolate milk, and soda
- Energy drinks: energy shots (more concentrated) and also includes for sports
- Dietary supplements
- Over-the-counter drugs

A Study: Caffeine and Its Impact on Newborn Anthropometric Measurements

Researchers

The main objective of this study was to determine whether there was a relationship between caffeine intake and anthropometric measurements of neonatal or newborn babies. The measurements the researchers took included gestational age, weight, length, head circumference, chest circumference, and Apgar score (a test used to

assess the health of a newborn baby). The study followed 100 pregnant women in Warsaw, Poland over the course of their pregnancies, where they were interviewed by the same dietitian and given questionnaires to track their daily caffeine intakes. The portion sizes and brew times of each caffeinated beverage were monitored and kept as a control variable throughout all participants. Once their babies were born, midwives collected measurements on their newborns.

Findings & Relevancy

The researchers found that there was not a significant relationship between caffeine intake and neonatal anthropometric parameters. Nearly all factors received a p-value of greater than 0.05, while only gestational weight-gain received a p-value of 0.034, showing that it does have a statistically significant relationship with neonatal length. The study also found the "mean caffeine intake to be 68 +/- 51 mg/day," with only 79% of women consuming less than 100mg per day (Wierzejska et al.). Along with this, the main source of caffeine was tea (63%) and coffee with the remaining amount (37%), while only a small percentage of women ever consumed energy drinks. Tea consumption varied, from 1 cup to 4-8 cups. However, a vast majority consumed 1 to 3 cups daily, with a light to medium brew.

Although the research behind the effects of high maternal caffeine intake leading to miscarriage, premature birth, and low-birth neonatal weight is inconclusive and still has varying evidence, the study still gives insight into reasons the results came to be. Specifically, the cultural differences in each country to drink certain caffeine sources over the others. For example, the study notes in their results that women in Japan tend to exceed the 200mg/day limit (67%), while countries such as the United States and United Kingdom tend to keep consumption lower with a mean of 58-125mg and 159 mg, respectively. The reason for higher numbers of caffeine consumption in the UK and Japan compared to the US is likely due to the appreciation of teas in those countries, as they are the most popular sources.

Potential Study Modifications

Carefully reading through the study, it seemed to be well-run and organized due to the precision and carefulness required to answer the questionnaires and document the daily intakes of each woman. While this is a hard task, there were modifications that could have possibly made the results more accurate in terms of fitting it to the population of pregnant women in Poland. This includes increasing the sample size significantly to where maybe the study is replicated in a different area of the country to ensure that women from all around are being represented. Secondly, there could have been options for more caffeine sources on the questionnaire, as it just asked about coffee, tea, and energy drinks. Other sources like soft drinks were disregarded. It is important to note that this was only a preliminary study, meaning that there could be different results later on.

Conclusion & Take-Aways

Throughout this investigation, a basic understanding of caffeine, the nutrient of choice, was reached, while applying that information to a new finding from an alternative perspective. Being able to learn from experienced researchers' work has been beneficial and enriching as a student, as well as maturing secondary research skills in the process. Applying these skills and techniques are important as a college student, as well as for potential job opportunities in the future.

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All About Beta-Cryptoxanthin

Beta-cryptoxanthin (BCX) is a carotenoid that is found in fruit and also in human blood and tissues. Foods that are rich in beta-cryptoxanthin include tangerines and oranges. A fun fact about this nutrient is that it can reduce the risk of osteoporosis if you take a high BCX intake and it's also vitamin A. Nobody discovered Cryptoxanthin as weird as it seems. This nutrient is very important for the human body because the fruits and vegetables containing beta-cryptoxanthin contain vitamin A, which is useful for eyesight, growth, and development. It could also reduce certain cancer types such as lung cancer. It functions as a very beneficial nutrient and has antioxidant defense and cell to cell communication. It's important for health and can improve the immune system. We already have an abundance of this nutrient in our body. It can be found in the human blood with other abundant carotenoids. High levels of cryptoxanthin should not be consumed. 0.2 and 0.3 mg of cryptoxanthin should be taken daily. There are no adverse impacts if a person receives too much or too little of this nutrient. The absorption of B-carotene from food varies greatly. The presence of absence of fat and human factors such as health status or genetic differences. The absorption of B-cryptoxanthin is probably influenced by many of the same factors that influence the absorption and bioavailability of other carotenoids. The adverse impacts of a person consuming B-cryptoxanthin depends on a number of factors including nutritional status, genetics, and digestive health of the person, the amount and type of carotenoids present, and the presence of fat. Our body processes this nutrient by converting it into vitamin A and it's also absorbed in the intestines by micelles, which contain bile salts and lipids. Once beta-cryptoxanthin is absorbed into the body, it's then converted to retinol, which is an active form of vitamin A in the body, which is stored in body tissue. This plays an important role in vision, cell growth, and maintaining healthy organs like the heart, lungs, and kidneys. Beta-cryptoxanthin is stored in the human body. The efficiency of conversion of beta-carotene to retinol depends on the level in the diet. If you eat more beta-carotene, then less is converted and stored. The rest is stored in fat reserves in the body. Cryptoxanthin is a common carotenoid that is found in fruit, vegetables, and in human blood and tissues. Foods that are rich of this nutrient include tangerines, persimmons, oranges, and peaches. This nutrient can already be found in the human blood and tissues. We might not know it, but cryptoxanthin keeps producing in our body every day. Cryptoxanthin is never added to any fruit or vegetables. It isn't genetically modified, but instead occurs naturally in many fruits. To my understanding, beta-carotenoids are some of the most vital colored phytochemicals and the coloration of fruits and vegetables depends on their growth maturity, concentration of carotenoid, and food processing methods. If the fruit or vegetable does not have enough coloration, then an artificial pigment could be created for some people who are insufficient in Vitamin D. Furthermore, Beta-Cryptoxanthin can also be taken as a supplement. It could help people with serious health conditions. They can be used in someone who has a vitamin A deficiency. But these supplements can sometimes be dangerous, because an overdose can cause serious problems and could turn your skin yellow or orange. The current research article that I found about this nutrient is from PubMed, and the article is titled, "Effects of B-Cryptoxanthin on improvement in Osteoporosis risk, a systematic review and meta-analysis of observational studies," written in 2021. The article is about how a very high BCX intake can potentially reduce the risk of osteoporosis and hip fracture. There is also a lack of quantitative analysis on the effect of BCX on bone health, so

scientists created mathematical models and conducted a review to reveal the association of BCX with osteoporosis and common bone fractures. They also extracted data from private websites to conduct this research. Overall, they wanted to find an association between osteoporosis-related outcomes and BCX intake. As a result, they had a 95% accuracy with their research and experimentation. This finding is significant because it will revolutionize the field of medicine by exploring more in depth with the Cryptoxanthin nutrient. Since this type of research is new and never done before, it's always important to research new things. This study is interesting to me because I always get excited when there's a medical breakthrough. It makes me want to learn more. Overall Beta-Cryptoxanthin is a very beneficial nutrient that improves the health of the human body, and decreases the risk of certain cancer types, and helps reduce osteoporosis and bone hip fracture. If I was a scientist, the next experiment I would perform with the Beta-Cryptoxanthin nutrient would be to see if it can improve the immune system.

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Leucine

Leucine, chemically known as aminohexanoic acid, is an essential, branched chain amino acid in the human body with contributions to many essential functions including the regulation of blood-sugar levels, growth and repair of tissues, growth hormone production, and wound healing. After trauma or extreme stress on muscles, it prevents the breakdown of muscle proteins. A white, crystalline solid with the molecular formula $C_6H_{13}NO_2$, it was first discovered by Protist in 1819 by being isolated from cheese. It was later crystallized from muscle by Braconnot and given the nickname "Leu" (Li).

Leucine is considered an essential amino acid because the body cannot make it, but it is available from food sources. Although The Food and Drug Administration does not regulate supplements, leucine can be found in salmon, chickpeas, chicken, seeds, and many more common items (Li).

Leucine is a part of a group of three amino acids called BCAAs (branched chain amino acids) which includes: leucine, isoleucine, and valine. BCAAs makeup approximately one third of muscle protein (Patel). The name, "Branched chain," relates to the structure that can be found in eggs, meat, and other high-protein foods (Walle). Researchers began studying the role of BCAAs in protein synthesis in the 1970s (Li) and found that leucine plays the most important role in protein synthesis because it stimulates the highest level of activation in the protein mTOR, has a higher oxidation rate, and the carbon skeleton can be used to generate ATP (National Center for Biology Information).

While there are many proven benefits of BCAAs, leucine specifically activates pathways that stimulate protein muscle synthesis. There was a study performed where people consumed 5.6 grams of BCAAs and had a 22% greater increase in protein activation, but the study showed, compared to whey protein, BCAAs cannot increase protein synthesis without the other essential amino acids (Walle). This study shows other forms of protein consumption are more effective than BCAAs alone.

Although leucine supplementation has been studied for a variety of reasons such as aging, protein deprivation, obesity, and diabetes mellitus. The current recommended dietary intake of leucine is "4 mg/kg body weight/day to a minimum of 45 mg/kg body weight/day with higher rates for more active individuals" (Mero). This amount of leucine can be consumed by eating a normal amount of high protein foods without supplementation.

Leucine striked the consumer industry of dietary supplements to stimulate muscle protein synthesis, but many of these studies showing supplementation of these amino acids improve exercise performance and help exercise recovery are not reliable. One research study shows consumption of BCAAs before or during high endurance exercises can decrease the net rate of protein degradation. However, leucine supplements 50 minutes before exercise had no effect (Poulson).

BCAAs can be included in multivitamins and food supplements that can come in forms of tablets, fluids, or powders. But, by ingesting enough protein in your diet, supplements are not necessary. By using supplements, the effects could lead to a negative balance of nitrogen that can decrease the effectiveness of the body's

metabolism. Research shows high doses of leucine can result in hypoglycemia (low blood sugar), pellagra, skin loss, hair loss, and gastrointestinal problems. Children can also experience growth problems from an excess amount of leucine (Poulson)

Leucine supplementation is unnecessary with a proper intake of high-protein foods, but with decreased BCAA levels, mRNA can become impaired and lead to protein wasting. Therefore, supplementation can be necessary in the occurrence of liver cirrhosis, urea cycles disorders, and chronic renal insufficiency (Holeček).

While BCAAs have been studied to show that their protein anabolic properties can help with muscle wasting disorders, there is no consensus on their therapeutic effectiveness. A study done by Milan Holeček proves the effectiveness of BCAAs in therapy of chronic renal failure (Holeček). Chronic renal failure is the "decrease in the kidneys' ability to filter waste and fluid from the blood" (Ada's Medical Knowledge Team). In this study, he proves alterations in BCAAs can have therapeutic advantages, and more studies should be developed to increase effectiveness (Holeček).

"Leu" is an important amino acid with functions that are essential to protein synthesis in the body. Increasing the intake of leucine through supplements is not necessary and can even have negative effects. But leucine, alongside the other BCAAs, increase muscle growth, decrease muscle soreness, reduce exercise fatigue, and prevent muscle wasting which are crucial to human development (Walle). Without it, we would never be as strong as we are today.

Most of the research I focused on related to the supplementation of leucine in products. Throughout my search for reliable sources, I came across many that focused on consumerism rather than facts, which I found especially interesting. While it theoretically makes sense since the more protein synthesis occurs more muscle would develop, research shows too much could lead to negative effects. I have learned that researching and looking for reliable sources, rather than ones that are trying to sell you a product, is important in finding true information. Moving forward, more research should be done on the therapeutic benefits of leucine and the impact it has on people with low levels in order to help others.

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Vitamin D2

Ergocalciferol, more commonly known as Vitamin D2, is one of the two main forms of Vitamin D. The discovery of Vitamin D arose from the attempt to find a cure for rickets. The high incidence of the disease in Great Britain was a cause of concern for many. Sir Edward Mellanby was the first to link the disease to a dietary issue. He used the diet of Scottish people, in whom the disease was most commonly found, and fed it to dogs. These dogs developed rickets, much like the human condition, which could be cured with cod liver oil. However, Sir Edward Mellanby incorrectly linked the disease to Vitamin A, instead of D.

Although the conclusion was incorrect, this finding led McCollum to test this hypothesis. He destroyed the vitamin A in the cod liver oil and found that this was still effective in treating rickets. This led McCollum to the conclusion that a new vitamin was responsible for curing rickets, Vitamin D. After this, a team of scientists isolated and identified the structure of Vitamin D, which led to the identification of Vitamin D2 in 1932.

Vitamin D2 is useful for raising Vitamin D levels to absorb calcium and treating hypoparathyroidism (the decreased functioning of the parathyroid glands which regulate calcium in bodies). Additionally, it can treat rickets (a disease caused by Vitamin D deficiency) and hypophosphatemia (low levels of phosphate in the body). If someone overdoses on Vitamin D2, they could experience nausea, loss of appetite, thirst, body aches, stiffness, confusion, irregular heartbeats, and even some life-threatening side effects. Vitamin D2 cannot be taken if one has an allergic reaction to Vitamin D, high levels of Vitamin D, or high levels of calcium.

The body first absorbs Vitamin D2 through the skin, food, or supplements, then stores it in the body's fat cells. It remains inactive here until the body needs it. The liver and kidneys turn the stored substance into calcitriol, the active form that the body needs, through a process called hydroxylation.

The body does not produce Vitamin D2 on its own. It has to absorb it from sunlight, food, or supplements. Vitamin D2 is found in plants and yeast. Some manufacturers add Vitamin D2 to their products. Some products where D2 may have been added include oat milk, almond milk, soy milk, orange juice, cereal, etc. The amount of D2 added to a product can be found on the label. D2 may also be found in foods naturally. Mushrooms and yeast with a high exposure to sunlight contain high levels of D2.

Due to the Covid-19 pandemic, researchers evaluated the effect of 25(OH)D, which is produced by Vitamin D2, on the risk of infection. They came upon this hypothesis due to the fact that black women often have a 25(OH)D deficiency and are also overrepresented among Covid cases. The researchers found that black women with a lowered level of 25(OH)D were at a higher risk of infection. These findings are important since they suggest the contribution and importance of Vitamin D2 in preventing modern-day issues such as Covid. I found this study interesting since I had never thought of Covid prevention through any means besides the vaccine. I find it fascinating that our diet and nutrition can play a role in preventing this disease. If I was a scientist, I would conduct the same experiment on other racial and gender groups. This study was limited only to black women, which may have caused other factors such as genetics to become a confounding variable in the findings. If the

findings can be replicated in other groups, there will be a greater chance that the findings are accurate. The next experiment I would want to perform regarding this nutrition is the effectiveness of D2 compared to D3. There is much research out there that argues both sides, however, a consensus has not been reached within the scientific community. I would like to expand on the research conducted by both sides to come to a definitive answer of whether D2 or D3 is better than the other.

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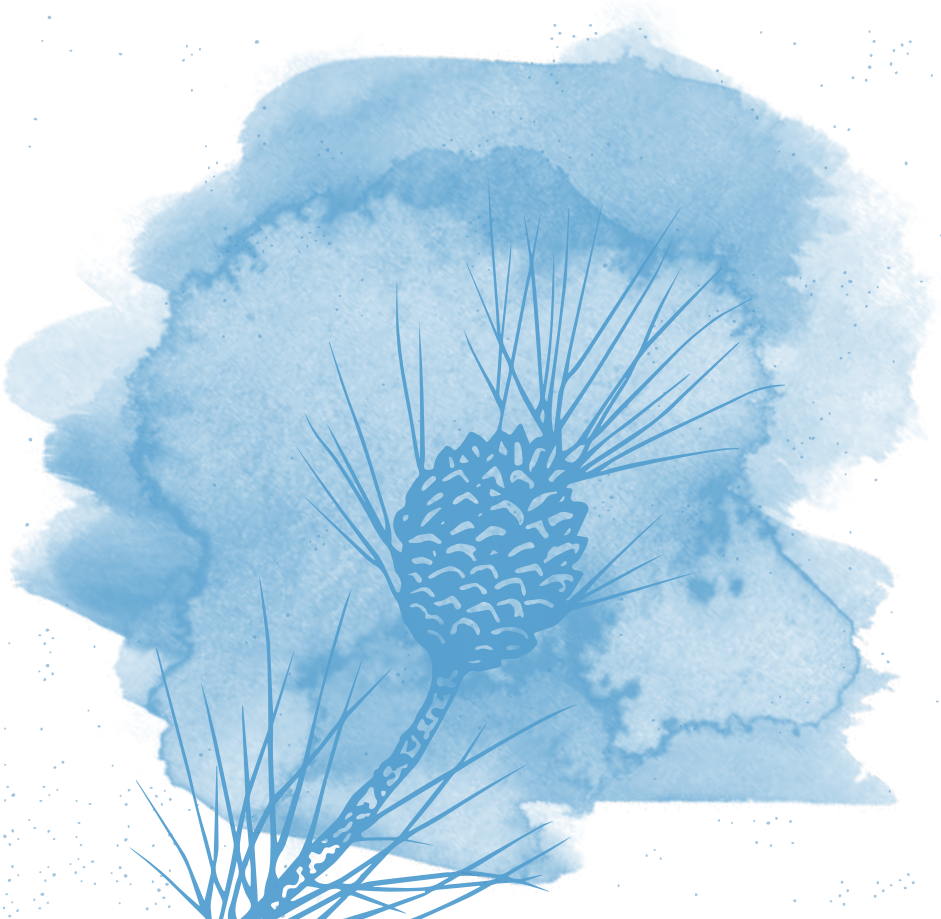

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Copper

The nutrient I chose to share about is copper. I chose copper because a close friend of mine has Wilson's disease and I wanted to learn more about the disease and how copper is related. The name's origin comes from the Latin word Cuprum, the island of Cypress where copper was first mined. Copper is an essential nutrient; it is the third most abundant trace mineral. It is used for various bodily functions and is found in all body tissues. It helps metabolize protein, and it works alongside iron to form red blood cells. It keeps blood vessels, nerves, the immune system, and bones healthy. It also aids in the absorption of iron and is used for brain functions. Copper is absorbed by the small intestine into the bloodstream. Copper is a trace essential mineral; you need small amounts of it that come from various types of food. You can obtain copper from a diet that includes avocado, nuts, organ meats such as liver, leafy greens, beets, chickpeas, seafood, dark chocolate, sunflower seeds, tofu, and many more. Adults usually have from 50 - 120 milligrams of copper in their body, which is found in muscles and in the liver. Copper is an important nutrient but there are complications if a person does not have the right quantity. Copper toxicity is when you have too much copper in your body. A common cause of this phenomenon is contaminated water. Other causes for copper toxicity are too much copper intake from food, being exposed to fungicides, and Wilson's disease. Excessive copper can cause liver damage, vomiting, diarrhea, and cramping.

Wilson's Disease

Wilson's disease is caused by a recessive gene and can only be inherited by carriers of this certain gene. Carriers can get mild symptoms but nothing that needs serious medical attention. The disease interferes with the excretion of copper, it causes copper to build up in vital organs such as the liver, the brain, and eyes. The buildup of copper can cause cirrhosis, otherwise known as scarring of the liver, problems with speech, uncontrolled movements, muscle stiffness, and Kayser-Fleischer ring (Brownish golden rings in the peripheral cornea, caused by the buildup of copper in the eyes.) Wilson's disease is caused by the alteration of the ATP7B gene (holds the instructions to create copper). If the disease is found early on, it can be treated and people with it usually carry on with a normal life. There are 5 different methods to treat Wilson's, penicillamine; trientine; zinc sulfate or acetate; and ammonium tetrathiomolybdate. These drugs either reduce copper levels or transform copper into metabolically inert and unavailable in the patient.

Copper Deficiency

Copper deficiency is a lack of copper in the body. Some causes of copper deficiency are lack of copper through diet, underlying health issues, and Menkes syndrome. Copper deficiency is usually found in kids with malnutrition, hospitalized patients, and young pregnant women. Copper deficiency can cause connective tissue, muscle weakness, white blood cell count, amenia, neurological disorders, and paleness.

Menkes Syndrome

Menkes syndrome impacts the way your body processes copper, it mainly affects the nervous system and connective tissue. Symptoms of Menkes syndrome are usually found in the first few months after birth which includes, sparse, kinky hair;

slow growth, seizures, other features are hypotonia, sagging facial features, and developmental and intellectual disabilities. Menkes is fatal, most kids that have severe symptoms don't live past the age of 4. There are less severe forms of Menkes syndrome such as occipital horn syndrome which begins in early to middle childhood. The adult-onset form is the least severe and mainly impacts nerves and muscles. There is no permanent treatment for Menkes syndrome, but early treatment with copper can improve long-term outcomes in some children. Menkes syndrome is more common in boys. Menkes is caused by mutations in the ATP7A gene, different from the ATP7B gene that Wilson's disease is caused by. Menkes syndrome is more common in boys.

Research Article

The research article I choose for my project is "Copper and Iron Metabolism", it is written by Miguel Arredondo and Marco T Núñez in affiliation with Nutrition and Food Technology Institute, University of Chile, Casilla 13811, Santiago, Chile. They found that the metabolic fates of iron and copper are related. An example that they list is "Systemic copper deficiency generates cellular iron deficiency, which in humans results in diminished work capacity, reduced intellectual capacity, diminished growth, alterations in bone mineralization, and diminished immune response." Copper is essential for the function of over 30 proteins, iron is also required for many essential proteins such as heme-containing proteins. They also say that the essentiality of copper and iron resides in their ability to participate in one-electron exchange reactions, but this process also causes free radicals and it is why it is important to keep stable iron and copper levels in the body. This is important because it means that if your iron or copper levels are not adequate, it would affect the other. It could affect how doctors would look for copper or iron deficiency. It is interesting that copper and iron are related closely together, and they both affect the other in many different ways. I would compare the differences between copper and iron deficiency and toxicity.

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Caffeine

Across the world, caffeine plays an important role in keeping society afloat through its wide assortment of coffees, teas, chocolates, and sodas. It serves as a widespread dietary ingredient, and a staple in many people's everyday diets. Though overconsumption may come with some unwanted side effects, caffeine can work quickly to improve energy, increase dopamine levels, and enhance your level of focus.

Also known as 1,3,7 trimethylxanthine, caffeine is a stimulant that can enhance concentration and reduce fatigue. Caffeine is a drug, but it is incredibly socially acceptable to consume. An overwhelming portion of caffeine consumption in the US comes from coffee, with over 62% of American adults drinking at least a cup a day.

According to legend, coffee was introduced to society after an Ethiopian goat herder noticed his herd was very energetic & unable to sleep after consuming a certain berry. He then made the seed of this berry (coffee bean) into a drink which he shared with a local monastery. The monks were very fond of the drink that could help them concentrate for many hours of prayer at a time, and this drink subsequently spread across the region. By the 16th century, coffee had traveled and become widespread across the Middle East, inspiring the creation of public coffee houses, which were home to much intellectual discourse.

First discovered and identified in 1891 by German chemist Friedlieb Ferdinand Runge, caffeine has made quite a name for itself. Runge was able to isolate caffeine as a single nutrient after being gifted a rare box of mocha beans from a friend who requested a study on them. Since then, countless scientists/nutritionists have observed caffeine's effect on the human body & mind.

Caffeine is a stimulant that works through binding to the adenosine neurotransmitter, speeding up thought and effectively blocking our brain from getting the message that we are tired. Presence of caffeine in a body can also lower levels of melatonin (and make it harder to sleep) because both are processed in the liver. Caffeine is not a necessity for bodily function, so there are no adverse impacts from not receiving enough unless a person is going through withdrawal after a dependency on caffeine. Though addictive, caffeine is predicted to be safe for consumption of up to 400 mg a day (4 cups of coffee) for adults, 100 mg a day for kids 12+, and 200 mg a day for pregnant women. If a person was to receive too much caffeine for their size and health they could face higher body temperature, faster breathing and heart rate, increasing anxiety, and an inability to sleep.

The body processes caffeine mainly in the liver and gut, where caffeinated beverages quickly dissolve into water and fat molecules. From this point it is able to access the brain. Depending on what else is in a person's stomach, caffeine levels in the bloodstream can peak anywhere from 15 minutes to 2 hours after consumption. Caffeine can also remain in the bloodstream from 1.5 to 9.5 hours. Other foods in the gut at the same time caffeine is consumed can slow down the rate of absorption into the bloodstream. This explains why drinking a cup of coffee before breakfast in the morning may allow for the caffeine to kick in faster, waking you up quicker. Because there is no nutritional need for caffeine, it is unnecessary to store it in the body. Caffeine enters the bloodstream and is disposed hours after consumption when one urinates.

The only way to receive caffeine is from foods/beverages, our bodies cannot produce it. The most popular way of consuming caffeine is drinking coffee, tea, soda, and energy drinks. In these drinks their caffeine comes from the seeds, berries, and leaves of coffea arabica, thea sinesis, and paulinnia cupana (guarana). People can also get caffeine from chocolate, with dark chocolate containing 4 times the amount of caffeine as milk chocolate, both types having their caffeine stem from the seeds of the Theobroma Cacao. Caffeine supplements typically containing 100-200 mg are popular and safe alternatives to sources of consumed caffeine for an energy boost.

There have been many interesting studies of the impacts of caffeine on brain functions and memory. I chose a 2014 study on the influence of caffeine on long-term memory because I never really considered that caffeine would affect anything longer than the short term. Studies before this one on the effect of caffein on long-term memory showed no statistical difference between caffeinated and baseline individuals, the difference with this study was that subjects didn't consume their given caffeine supplement or placebo until after seeing the images they were supposed to recall. This allowed the scientists to isolate subject's ability to recall old and similar images to just the caffeine consumed after, not how alert they were when first viewing the images. This experiment showed significant statistical evidence that post-study caffeine consumption boosts long-term memory. One of the main theories of why these results occur is that when caffeine blocks adenosine, it could prevent it (adenosine) from interfering with norepinephrine, which is partially responsible for the consolidation of memory. This finding is important because it opens up new questions and potential into the use of caffeine to enhance memory. This is really interesting to me because though I don't regularly drink caffeine now, if new positives of caffeine consumption like improved memory continue to come out, it may provide a reason for me to drink coffee more often. If I was a scientist, I would have started with a larger sample size, by the end of this study they only had 10 subjects because the rest did not follow protocol, so the end results are not as statistically accurate as ideal. The next experiment I would want to perform with caffeine would be to test if it can alter the recollection of patients with Alzheimer's.

Caffeine is a versatile and compelling nutrient that is very popular and only increasing in popularity across the world. Its effects on mood, energy, and concentration benefit many people in their everyday lives and caffeine's profitability props up a lot of business for farmers. With continuing research coming out proving benefits of consuming caffeine, its popularity is no surprise, even considering caffeine is a drug.

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Calcium

Calcium is a nutrient found in the human body that serves several functions that support the structure and function of bones, teeth, and other body tissue. The term calcium originates from the Latin word, calx, translating to "lime." The nutrient was discovered approximately 213 years ago in 1808 by British chemist Sir Humphry Davy. Prior to Davy's discovery, chemist Jöns Jacob Berzelius and Swedish physician M.M. Pontin prepared the element calcium amalgam by electrolyzing lime in mercury. Davy, however, was the first individual to isolate calcium from their electrolysis and officially discover the element. It then became known to be the most abundant and common nutrient within the body, serving various functions that aid in the health of human beings.

One percent of calcium within the body serves several purposes such as metabolic functions including vascular contraction and vasodilation, hormonal secretion, muscle function, intracellular signaling, and nerve transmission. Bone tissue stores calcium to sustain consistent concentrations throughout the blood, muscle, and intercellular fluids within the body. The other ninety-nine percent of the calcium supply in the body lies within the bones and the teeth and supports their functions. Remodeling of the bones constantly occurs within the body, allowing for frequent resorption and deposition of calcium into new bones necessary to maintain structure and stability. Body resorption, or the process of calcium being absorbed into the circulation of bodily cells and tissue, varies depending on factors such as age and gender. Due to the varying needs of the bones, intake of calcium is different depending on the age and gender of consumers. Additional factors for women such as pregnancy and lactation are relevant as well, due to internal activity within the body that may lessen the amount of calcium reabsorbed into the bones. Therefore, the recommended dietary allowance differs for each individual. The recommended dietary intake daily for infants 0 to 6 months is 200 milligrams, for 7 to 12 months is 260 milligrams, and for 1- to 3-year-olds is 700 milligrams. The intake increases as one gets older, then decreases again. For 4- to 8-year-olds it is 1,000 milligrams, 9-to-18 year-olds is 1,300 milligrams, and 19-to-70-year olds is 1,000 milligrams, and for adults over 71 it is 1,200 milligrams.

While inadequate intake for the short term does not have detrimental effects, failure to consume enough calcium can result in deficiencies that lead to more severe health issues. Osteopenia, a medical condition that weakens bones and causes loss in bone mass, can develop as a result of lack of calcium. If untreated, osteopenia can progress into osteoporosis, a severe disorder that increases chances of bone fractures from daily activities. Postmenopausal women, amenorreheic women, and individuals with lactose intolerance or an allergy to cow milk are subject to an increased risk of calcium deficiency. Postmenopausal and amenorreheic women have this risk due estrogen levels within the body that poorly impact calcium absorption. As difficulties come with inadequate intake of calcium, there are issues that occur with excessive intake of calcium, known as hypercalcemia. This condition can induce poor function of the kidneys, vascular calcification, excessive amounts of calcium in the urine, kidney stones, and constipation. The occurrence of hypercalcemia is often a result of excessive consumption of calcium supplements rather than from natural or fortified foods.

The body is unable to produce calcium on its own, therefore it must enter the body through foods or supplements. Calcium is found naturally in dairy products such as milk, yogurt, and cheese, and it is also found in Chinese cabbage, kale, almonds,

salmon, and broccoli. It can be added to a variety of foods, some of which are tofu, cereals, and fruit juices. Foods that have increased effects of calcium are fortified. Calcium is frequently used as a dietary supplement, with two main differences. Calcium carbonate is the type of calcium found in supplements more widely available to individuals, while calcium citrate is primarily used for people with absorption disorders or inflammatory conditions such as bowel disease. The body processes calcium following consumption, where it is absorbed based on conditions within a tubular structure in the small intestine. While in the stomach, it is transformed into a salt that is absorbed in the duodenum of the stomach. It is also absorbed in the lining of the small intestine and into the bloodstream, where it begins to build and strengthen bones and perform its other bodily functions. As it is consumed, the body continuously resorps and deposits calcium into newer bones to ensure stability and structure, as well as performs other functions previously mentioned.

Scientists conduct different kinds of research on calcium in order to gain new information on the effects, both positive and negative, that the nutrient has on the body. A research experiment that involved cases of clinical trials performed by the Copenhagen Consensus Center studied the exceedingly high maternal deaths and birth complications in Ghana, questioning whether the inadequate intake of nutrients results in adverse circumstances for pregnant women. Due to micronutrients such as calcium being substandard in developing countries, women are unable to incorporate such nutrients into their diet and face health circumstances linked to maternal anemia, night blindness, miscarriages, fatality during childbirth due to hypertensive disorders, preterm births, low birth rates for their children, and death. Because many childbirths occurred due to hypertensive disorders, 14 clinical trials assessed the effects of calcium supplementations on pregnant women. Data recorded that women who consumed greater doses of calcium were less likely to deliver preterm babies and have a reduced risk of hypertensive disorders occurring throughout pregnancy. While micronutrients and calcium supplementation are not standard health policy in Ghana, obtaining of supplements, development of systems pertaining to the procurement of supplements, and health care training are steps that can be taken to initiate the use of these. The research conducted is extremely important because this newfound information can be used to protect the lives of mothers and their infants, as well as decrease chances of health conditions occurring throughout pregnancy and in childbirth. Additionally, it allows scientists to gain more knowledge on the positive effects that calcium can have on the body. I find this study interesting because it showed a visible decrease in adversities with childbirth and significantly improved the health of the women at trial by providing them with optimal micronutrients. The lives of pregnant women are constantly at risk in poorer countries due to circumstances such as suboptimal nutrients and lack of calcium consumption, and scientists having the ability to make improvements in health is extremely beneficial for women who have high chances of fatality during childbirth. I believe that I would have followed the footsteps of the scientists who led this research, and I would not choose to do anything different. However, in my next research, I would like to study other complications that occur during birth that are related to a lack of nutrient consumption and conduct clinical trials to see whether or not the consumption of certain nutrients decreases risks in pregnancy and birth. I would evaluate the health of the women during pregnancy, then continue to study the health of their children and their development for the first years of their life. Calcium and its functions play a significant role in humans' everyday lives. Following my research has allowed me to obtain information on the benefits and functions it has on the body and make future connections to how it affects our day to day lives.

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Riboflavin

Riboflavin, also known as vitamin B-2, is a water-soluble vitamin that is needed for body growth. This vitamin was first observed in 1872 by English chemist Alexander Wynter Blyth as a "pigment in milk with yellow-green fluorescence." When riboflavin was originally isolated from milk whey in 1879, it was given the name lactochrome. Even though it was observed in the 1870s, this substance was not characterized as riboflavin until 60 years later in the early 1930s. When in its pure form, riboflavin can be an orange-yellow crystalline substance with poor solubility in water. Riboflavin was the second vitamin to be isolated and was the first to be isolated from the vitamin B-2 complex. The essential nature of riboflavin as a part of food was shown in 1939. Foods with riboflavin should be stored in containers that are not exposed to light because riboflavin is destroyed by exposure to light.

Riboflavin is used in the body to metabolize fats, protein, and carbohydrates into glucose for energy. It is also used as an antioxidant that helps aid in proper function of healthy skin, hair and immune system. Recent studies have also shown riboflavin to play a role in protecting against cardiovascular disease and cancer. The active form of riboflavin acts as a coenzyme that facilitates the functions of many flavoproteins. Flavoproteins are a group of mitochondrial enzymes that are a key factor in the body's metabolic process. The flavoproteins play a role in protecting the cell membrane and are also part of cellular apoptosis that is required to get unwanted cells out of the body.

Riboflavin plays an important role in how the body processes certain chemicals, minerals, and vitamins. According to the American Journal of Clinical Nutrition, riboflavin is important to how the body processes iron; without it, the body is more likely to develop anemia. Another example is the reaction of riboflavin with vitamin B9 (folate) and vitamin B6. The body needs riboflavin to change these vitamins into forms that the body can use. Without a healthy level of B2 the body would not be able to process many of these important vitamins and minerals.

The recommended daily allowance (RDA) of Riboflavin needed differs between different ages and sex. The recommended daily value of Riboflavin needed in males age 14 and older is 1.3 mg. For females ages 14-18, the recommended value is 1.0 mg daily and 1.1 mg for females ages 19 and older. For pregnant women, the RDA of riboflavin increases to 1.6 mg a day. According to Dr. Kristine Arthur, internist at Orange Coast Memorial Medical Center in Fountain Valley, California, "RDA is 1.3 milligrams daily for men and 1.1 mg for women. A higher dose of 3 mg per day can help to prevent cataracts. Higher doses up to 400 mg can be used to treat migraine headaches." Some health conditions may also increase the body's need for riboflavin. Some of these conditions include intestinal or liver diseases, serious injury, surgical removal of the stomach, overactive thyroid, continuous fever or illness, cancer, burns, and/or alcoholism.

Riboflavin is found in a variety of food sources such as milk, nuts, dairy products, eggs, green leafy vegetables, lean meats, legumes, and organ meats (liver and kidneys). You can also find riboflavin in fortified bread and cereals. According to the US Department of Agriculture, a glass of whole milk has 0.4 mg, a hard-boiled egg has 0.3 mg, a cup of chopped kale has 0.1 mg and a cup of whole almonds has 1.4 mg. Riboflavin can also be taken as a supplement if you are not able to reach your daily needs through food. Riboflavin is usually included in B-complex vitamins and multivitamins but is also

available separately in 25mg, 50 mg, and 100 mg doses.

The medical name for clinical riboflavin deficiency is Ariboflavinosis. Riboflavin deficiency is frequently combined with deficiency of other water-soluble vitamins. The side effects of being deficient in Riboflavin may appear in the form of a sore throat, anemia, inflammation of the skin, mouth or lip sores and swelling of soft tissue in the mouth. According to the American Journal of Clinical Nutrition, these symptoms can show up after just a few days of being deficient. Being deficient in riboflavin can also lead to many developmental abnormalities, such as growth retardation, cardiac disease and cleft lip and palate.

Riboflavin deficiency is rare in the United States. It is more common in developing countries in Africa and Asia. One risk group for riboflavin deficiency is alcoholics because of the decreased absorption, decreased intake and the impaired utilization of the vitamin. Another group of people at risk for riboflavin deficiency are individuals suffering from lactose intolerance because they may not consume the dairy and milk products that are good sources of riboflavin. Riboflavin deficiency is also a common issue in athletes whose diets are low in meat products. Vegetarian athletes are at risk for this deficiency because their needs are higher due to the stress exercise puts on the metabolic pathways that use riboflavin.

If too much riboflavin is consumed, the excess amounts leave the body through urine because riboflavin is a water-soluble vitamin. A side effect that some people notice when taking higher doses of B2 is the urine turns a bright yellow/orangish color. This is a harmless side effect and because the excess amounts are disposed through the urinary tract, riboflavin is considered safe at high doses.

The body processes riboflavin through our digestive tract. Because riboflavin is a water-soluble vitamin, the body does not store it. The vitamin has to be taken regularly to maintain the reserve. Most of the riboflavin we consume is absorbed quickly by the small intestine. In the inner lining of the bowel (the intestinal mucosal cells) the absorbed riboflavin is converted into its active forms, flavin adenine dinucleotide (FAD) and flavin mononucleotide (FMN). After the riboflavin is converted, these new forms get transported through the blood to different tissues to perform their functions of metabolizing nutrients, apoptosis and working as an antioxidant.

Currently, research supports that high doses of riboflavin are effective in reducing migraines. A clinical trial held by the University of Berlin's Department of Neurology in 2004 showed the effectiveness riboflavin can have in the prevention of migraines. This study was performed in a specialized outpatient clinic where the patients received 400mg capsules of riboflavin per day. Throughout the study, headache intensity, duration, use of abortive drugs, and frequency were recorded at baseline, 3 months into treatment and 6 months into treatment. The study showed that after 6 months, headache frequency was reduced from 4 days per month to 2 days per month. The study also showed that after 6 months, the number of anti migraine abortive drugs was reduced from 7 units per month to 4.5 units per month.

Another study held by The University of Bologna's Department of Neurological Sciences in October 2009 showed the effectiveness of riboflavin in childhood and adolescence migraine prevention. This study had 41 pediatric and adolescent patients take 200 or 400 mg of riboflavin for 3, 4 or 6 months. During the follow up after treatment, 68.4% of the patients had a 50% or more reduction in frequency and 21% reduc-

tion in intensity. This study concluded with the idea that riboflavin is an effective, low-cost, and well-tolerated treatment for children and adolescents who suffer from migraines.

Both of these studies show the benefit riboflavin can have on reducing migraine frequency and intensity. The results determined the dose needed to be effective is about 400 mg a day. This finding is important to migraine sufferers because it provides a treatment option with little or no side effects. Continued research in this area could give sufferers another treatment option to try as well. These studies are interesting to me because I personally suffer from migraines and am taking riboflavin as a treatment for them. If I were a scientist, the next study I would do is take note of the amount of riboflavin participants already consume daily through foods and see if proper nutrition also plays a role in migraine prevention. I think that continuing studying the effect riboflavin has long term (longer than 6 months) would also be a change I would make to augment both of these studies.

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Innovation

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Sodium: The Specifics

Sodium is often confused with table salt, a compound that includes sodium. However, sodium has its own importance as a dietary mineral that is found in food. Discovered in 1807 by Humphry Davy, an English chemist, this mineral has played a crucial role in society since the time of Homer. Although historians do not know when sodium first appeared in human diets, there is evidence that salt has been used for centuries, especially to preserve meats through a process called curing. A form of curing was used by Ancient Egyptians for mummification. Since salt has drying properties due to its apparent role as a solute in osmosis (a process by which water moves to areas that have a high solute concentration, so more salt means more water loss), mummies were embedded and filled with salt, so that the lack of moisture made them less likely to decompose. Today, salt is often utilized to cure meats. For instance, salami is made by mixing meat and salt and then fitting the mixture into a casing before hanging up to dry. The salt within the sausage then extracts the excess moisture that is left, leaving the meat chewier and more flavorful.

In addition to its use to dehydrate meats, sodium is a principal element in maintaining the health of human bodies. It is essential for the regulation of blood volume, blood pressure, muscle fibers, and nerve impulses. Owing to its importance, scientists have provided a daily recommended intake to meet nutritional requirements. For healthy adults, it is 2,300 mg, which is the equivalent of one teaspoon. Slight variation in blood sodium concentration is not harmful, but a deficiency or surplus of it can be detrimental to the human body. Insufficient sodium in the blood is associated with lethargy, seizures, and coma, while an oversupply is associated with loss of appetite, kidney damage, and mental confusion. To avert these symptoms, the human body has certain methods that are used to regulate blood sodium levels. The dietary mineral is absorbed from the gastrointestinal tract and when the concentration of blood sodium is too high (a condition called hypernatremia), the blood vessels and brain communicate with the kidneys to decrease blood volume by increasing the amount of sodium that is excreted into the blood. The process of sweating also results in sodium removal since the mineral is stored in the skin, which is why human sweat is salty. To combat low blood sodium (hyponatremia), the adrenal glands - one located on top of each kidney - are key components. The kidneys stimulate the glands to release a hormone called aldosterone, which causes the kidneys to retain sodium. Consequently, less sodium and water are excreted into the bloodstream, conserving sodium in the body and increasing blood volume. Sodium is also conserved when the body restricts the amount of sodium-containing fluid that is lost when sweating. In addition to its presence in the blood, sodium is also found in the extracellular space of cells. Through the sodium-potassium pump, sodium is pumped out of the cell and into the surrounding space as potassium is brought into the cell. This exchange of sodium for potassium is especially vital to the kidneys, whose main function is to filter the nutrients in the blood. When an individual has a sodium imbalance, it can hinder the pump's ability to transport nutrients in and out of the cell, a condition that may be life-threatening since the sodium-potassium pump lies on the outer membrane of nearly every cell in the human body.

Sodium is required for survival. Unexpectedly, it is not produced by the body. This means that it must be acquired from another source: food. The mineral can be found naturally in foods such as celery and beets. Yet, the amount of sodium in fresh

vegetables is negligible when compared to the amount found in most processed foods. Sodium is often added to these packaged and prepared products to serve as a preservative, to improve texture, and to enhance flavor. Thus, processed foods contain potentially dangerous levels of sodium. Among the sources of added sodium in these foods are monosodium glutamate (MSG) and baking soda. Ultra-processed foods like deli meats, soups, and chips contain even higher levels of sodium.

Additionally, nearly all restaurant foods are processed, and over 70% of the sodium that Americans consume is from both restaurant food and prepared/packaged foods. Predictably, the average American has a daily intake of around 3,400 mg of sodium, which is substantially more than the recommended 2,300 mg. For individuals who have lower sodium levels, however, they may need an elevated intake of the mineral. One treatment is to take the mineral orally in the form of table salt. In this form, table salt is considered a supplement, but this method of treatment is only specific to those with special dietary needs.

Since sodium is essential for proper body functioning, its effects on the human body continue to be researched. Recently, the American Heart Association Journal called Hypertension published a study about the relationship between salt sensitivity (when blood pressure is more likely to be impacted by the effects of sodium on the body) and high blood pressure. In this study, the salt sensitivity levels of 1,718 Chinese adults on a seven-day low-salt diet and a seven-day high salt diet were tracked for an average of 7.4 years. At the end of the study, it was found that those who had high salt sensitivity were 43% more likely to develop high blood pressure than those with moderate salt sensitivity. This is a significant finding because it suggests that high salt sensitivity may cause high blood pressure, a condition that increases the risk of serious chronic illnesses like cardiovascular disease and dementia. The study notes the dangers of excess sodium and warns that people should be cautious of how much sodium they are consuming daily – a recommendation that has been in effect by the USDA for decades, but unfortunately, has not resulted in changes in America's approach to the salt pandemic. It is especially intriguing how the participants in the study followed each diet for the same amount of time, alternating between the two, but still suffered from the negative consequences of the high-salt diet. Although the findings of the study are notable, there are limitations. The findings have yet to be applied to the general population since the research was primarily focused on Chinese adults. For this reason, analyzing a more diverse group of participants would be beneficial because it would broaden the scope of the study and allow more accurate results to be attained. Based on the results of a more robust study, a subsequent experiment may be to research why certain individuals have high salt sensitivity while others have low sensitivity. One possible study could be to test the blood types of subjects to determine if there is an association between blood type and salt sensitivity.

In conclusion, sodium plays a considerable role in human bodies, ranging from regulating the availability of nutrients in the blood to ensuring that certain parts of the cell operate properly. Food sources high in sodium levels should be monitored and limited to be part of a healthy diet. Those who are concerned with their levels of sodium consumption will greatly benefit from such a diet since it will help prevent health complications that are correlated with low or high blood sodium levels. Sodium has and will continue to impact the daily lives of people globally, and although there is ongoing research on this important mineral, there are still many questions that remain unanswered.

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Creatine and the Benefits of Supplementation

When most people think of creatine they think of bodybuilders and people with huge muscles, but creatine is essential for everyone from the highest performing athletes to someone who sits at a desk all day doing work. Put simply, creatine is an amino acid that is converted into phosphocreatine. Phosphocreatine is used to regenerate ATP from ADP giving the body energy to function. While creatine has proven benefits to building muscle and increased energy, a few studies are being conducted right now relating supplementing creatine to boosting cognitive function. While creatine was discovered in 1832 it has only been heavily researched since the 1970 to 1980 mark and became popular through supplemental use only after the Olympic games in 1992.

Creatine is important for the body because it is an amino acid that is used to create phosphocreatine. Phosphocreatine is a storage mechanism for muscle cells that allows them to take the adenine diphosphate produced by physical activity and convert it back into adenosine triphosphate which is what the body needs for energy. Creatine is found in two places in the body. It is mostly in the muscles and there is also a little bit in the brain, according to the Mayo Clinic. Creatine is naturally produced in the liver, kidney, and pancreas. The problem is that the body only creates about 1 gram of creatine a day and to get the most out of the nutrient it is recommended that 3-5 grams of creatine are taken per day. The rest of the creatine that is available in our body comes through our diet. Creatine is found in meats and about 1 pound of meat contains 1-3 grams of creatine. While that seems like enough to hit the 3-5 gram goal, a pound of chicken, which is one of the leanest and less caloric dense of the meats, is about 1100 calories. Most people eat an average of 2000-3000 calories a day and a third of that is usually not meat, so it is very hard for the average person to reach their creatine goal. The only negative to not having enough creatine in your body is not having the waste product of creatine, creatinine, in your body as that could be a sign of low muscle mass, liver problems, not enough protein in your body, pregnancy or illness. While some of these symptoms of low creatinine are not serious, some such as liver problems or deteriorating muscles could have serious effects on a person's health.

"In the process of regeneration of ATP, creatine phosphate transfers a high-energy phosphate to ADP. The products of this reaction are ATP and creatine (Jenkins)." Creatine is most known for its benefits on the muscles but it is also proven that taking creatine prevents injury. It is still being researched that creatine might increase cognitive and brain health, sarcopenia, and bone health, reducing heart failure and might help improve the skin. The side effects of creatine supplementation include bloating, dehydration if enough water is not consumed while on the supplement, and slight weight gain through increased water retention. Overall though, creatine is generally safe to take and has many benefits.

When it comes to supplementing creatine for athletes there are two popular methods: either through powder form (mixing it in water) or tablets. One serving is usually 5 grams a day and people either take it for 5 grams a day every day or for faster results it is recommended to do a loading phase where you take about 10-20 grams for the first 5-7 days then stay at the maintenance 5 grams. While both methods work about the same the only benefit the loading phase has is that it helps you look bigger a lot quicker as your muscles have more creatine in them and that means they can retain more water.

While most studies about creatine are about its benefits on muscle development and

athletic performance, those studies conclude the same thing and prove how creatine benefits athletes. The more interesting studies are about how creatine affects cognitive function in the older population as well as how it helps them move in day-to-day life. One study happened in May of 2011 and was done by Eric S. Rawson and Andrew C. Venezia. The study first explains that earlier studies have a well-documented trend of creatine supplementation increasing lean body mass and strength as well as giving people enhanced resistance to fatigue. The study then states as a person gets older and they start exercising less their muscles deteriorate. The study shows that older adults who take creatine can reverse this and it can give them increased strength, muscle mass, and bone density making it easier for their day-to-day lives. On top of that, in older adults, short-term high-dose creatine supplementation can increase body mass, enhance fatigue resistance, increase muscle strength, and improve their lives.

Because creatine is found in the brain there is a lot of research being done on whether it increases cognitive function. Well, in the younger population a connection has not been discovered yet, but in the older population, it has been discovered that through increasing the phosphocreatine in the brain through supplementation cognitive processing can be improved. Another study that backs up the evidence of Rawson and Venezia is a review done in 2018 by Eimar Dolan, Bruno Gualano, and Eric S. Rawson. Their review showed that creatine is more likely to help the brain and influence it to work better when cognitive processes are being stressed. Examples of this include sleep deprivation, experimental hypoxia, and during the performance of more complex, and thus more cognitively demanding tasks.

Even though creatine has been proven to help in these situations there is still a lot unknown about the benefits of its supplementation and whether or not it could or could not help with dementia and other cognitive disabilities. As time goes on it will be interesting to see whether technology will advance to see if it will be possible to study the neurological pathways of the brain while the subject is alive and going through day-to-day life. As much as autopsies and modern-day brain scans help scientists understand the brain and its inner workings, there is still so much unknown about the brain, our consciences, and the deterioration of our minds as we age and go through traumas. Even though it is not 100 percent proven that creatine supplementation helps long-term cognitive function it is proven that it helps short-term function and helps the mind when it is under stress. This is a huge step in the right direction and it will be very intriguing to see what the future holds for this nutrient. They say the brain is the body's most powerful "muscle" so maybe the key to getting it stronger is through creatine just like the body's other muscles.

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Iron and Its Implications in Severe Covid Symptoms

1. Introduction

Iron is an essential nutrient for humans. It is often referred to as the chemical symbol Fe by chemists. Since the ancient days, iron has been used to make weapons, tools, etc., but its importance in the human body was discovered in 1713 by Lemmery and Geofgroy. A 16th-century physician, Nicholas Monarde of Seville, claimed that iron was supposed to produce "great effects and marvelous works." Nicholas used iron for many unrelated ailments such as gout, acne, and alopecia [1].

2. Importance in the Human Body

Iron is a crucial element of blood production. Approximately 70 percent of our body's iron is present in your red blood cells found in the blood through the form of hemoglobin and myoglobin in muscle cells. Hemoglobin is responsible for transporting oxygen in our blood from the lungs to all the tissues. Myoglobin, found in muscle cells, accepts, stores, transports, and releases oxygen. Nearly 6 percent of the iron found in our body is a component of specific proteins, essential for respiration and energy metabolism [2].

Additionally, iron is necessary for the immune system to function correctly [2]. The amount of iron needed daily varies primarily on a person's age and sex. For instance, an infant 7-12 months requires 11 mg of iron daily, whereas a baby 1-3 years of age requires 7 mg daily. At the age of 4-8 years old, a child needs 10 mg of iron daily. A child of 9-13 years old requires 8 mg of iron daily. Eventually, as the human body starts to mature, there is a divide in the amount of iron needed for each sex. Typically, a female requires more iron than a male. A teenage male 14-18 years old only requires 11 mg of iron daily, whereas a female of the same age requires 15 mg of iron daily. A male 19-50 years old requires 8 mg of iron daily, and a female of the same age requires 18 mg of iron daily. After the age of 50, both males and females need 8 mg of iron daily. Of course, the necessary daily iron does change on some occasions. In pregnancy, women require 27 mg of iron daily to stay healthy [3].

If iron intake is consistently low, it leads to a condition called iron depletion. Eventually, suppose iron intake continues to stay low. In that case, it will lead to a condition called iron-deficient erythropoiesis, and even more decrease in iron stores leads to iron deficiency anemia [2], which causes symptoms such as fatigue and trouble breathing [4]. During anemia, the body does not have enough red blood cells to carry enough oxygen to the body's tissues [2]. If someone has excessive iron (iron overload) within the body, it can significantly damage the gastrointestinal system. The accumulation of extra iron also causes iron toxicity, leading to nausea, diarrhea, and stomach pain. Iron can also accumulate in the organs causing fatal damage to the liver or brain [5]. Current research shows a correlation between COVID-19 severity and iron dysfunction. Patients with anemia have shown fewer chances of recovery from COVID-19 [7]. Similarly, iron overload is said to contribute to possible symptoms of severe COVID-19 such as hypercoagulation, hyperferritinemia, inflammation, and immune dysfunction [6].

3. The use of iron in the human body

Even though iron is widely available in its natural form, it cannot be directly consumed by our bodies. For the body to use iron, it has to be absorbed from foods. The duodenum and proximal jejunum absorb the most iron in the human body [8]. The

amount of iron that is absorbed varies on many factors. Iron exists in the oxidized, ferric (Fe^{3+}) state, and for our bodies to absorb the iron, it has to be in the ferrous (Fe^{2+}) state, or it has to be bound to a protein called heme [8,12]. Eventually, the body takes out old red blood cells from circulation to get destroyed. The iron is scavenged by macrophages (a type of large white blood cells used by our immune systems) and returned to the storage supply for reuse [12].

The body stores iron. On average, an adult male stores 1,000 mg of iron, enough for about three years. The average adult female can store 300 mg of iron, enough for about six months [2].

4. Sources of iron

The body does not produce iron; instead, it is absorbed from the foods we eat. Iron is naturally found in food, and on some occasions, it is added to food for extra nutrients or flavor [10]. Some foods that naturally contain iron include shellfish, spinach, organ meats, legumes, red meat, broccoli, tofu, and dark chocolate [14]. Iron can be found as heme iron and non-heme iron [10]. Heme iron is derived from hemoglobin. It comes from animals that previously contained hemoglobin [11]. Heme iron is found in meat, seafood, and poultry. Non-heme iron is found in numerous plant foods, fortified foods, and it can also be found in animal flesh as animals also consume plant foods [10]. The human body absorbs heme iron better than non-heme iron. About 15% to 35% of heme iron is absorbed, whereas only 2% to 20% non-heme iron is absorbed. Although non-heme iron is not easily absorbed, it still makes the most significant contribution to the body's iron stores, as food contains more non-heme iron [9]. Depending on the type of food, cooking it on a cast-iron skillet can add iron to the food [13]. Typically, foods that are more acidic or moist absorb more iron [13]. Iron can also be taken as a supplement. They are mainly taken when one suffers from iron deficiency to increase iron and hemoglobin levels in the body.

5. Current research

As per a recent study, iron overload is said to contribute to severe COVID-19 symptoms like hypercoagulation, hyperferritinemia, inflammation, and immune dysfunction. As discussed in the research article, COVID-19 attacks hemoglobin, sets iron free from porphyrins, and discharges iron into the circulatory system, thus creating an iron overload condition. In order to balance iron overload, ferritin production is boosted. The increased ferritin levels can cause the death of hepatic cells, which leads to the release of iron from ferritin. This extra iron triggers the ferroptosis (a type of programmed cell death) process. If left untreated, it causes a series of reactions, which leads to inflammation, lung impairment, and multiple organ failure [6].

Additionally, a study shows that an individual with blood group type O is least likely to get COVID-19 related complications. In contrast, an individual with blood group type A is most likely to get COVID-19 associated complications. There is no direct relationship between blood group type and COVID-19, but patients with blood group type O tend to have lower serum iron (free iron) than other blood group types, which further shows a relationship between iron and COVID-19 [6].

Currently, iron overload is treated by lactoferrin and other iron chelators. As iron overload contributes to COVID-19, a patient with COVID-19 can be treated with lactoferrin or other iron chelators such as deferasirox, deferoxamine, and deferiprone. Iron chelators like lactoferrin can bind to heparan sulfate proteoglycans (HSPGs) located on the cell surface. This prevents the interaction between the virus and host

cell, preventing the entry of the virus into the host cell [6].

The COVID-19 virus has caused a rupture around the world. There are minimal ways to prevent COVID-19. The importance of another type of cure is very high. Lactoferrin and other iron chelators can be of high therapeutic value for the present COVID-19 pandemic.

Iron is a transporter of oxygen in our bodies. My understanding was that COVID-19 patients required more oxygen, which needed more iron, but more iron made COVID-19 complications more severe, as per the research article. The article contradicted my initial understanding, which made me want to learn more about the article.

During the study of this article, I didn't find any information regarding the correlation between iron deficiency and COVID-19. Using iron chelators to treat COVID-19 patients that have iron deficiency probably isn't safe. Like iron chelators can be used to treat COVID-19 patients with iron overload, I want to further research if there is a similar way to treat COVID-19 patients with iron deficiency.

In conclusion, a balance of iron is needed for the body to function correctly.

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Impact

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Vitamin D

Vitamin D (also known as ergocalciferol-D2, cholecalciferol-D3, alfacalcidol) is a fat-soluble vitamin that we intake and also a hormone our body makes. Not much was known about Vitamin D until its discovery in the 1900s. Sir Edward Mellanby in Great Britain was concerned regarding rickets in the United Kingdom. He studied the disease and experimented using dogs, eventually theorizing that Vitamin A prevents rickets. Johns Hopkins Professor Elmer McCollum found the study interesting and decided to test the hypothesis. McCollum correctly concluded that it was not Vitamin A, but a new vitamin which he named Vitamin D, that was responsible for the prevention of rickets.

Vitamin D is both produced by the body and contained in foods we consume. Our bodies create Vitamin D when in direct contact with sunlight. The sun's energy is absorbed by the skin to transform a chemical into vitamin D3 which then travels to the liver and kidney to become active vitamin D. Although sunlight is needed to make Vitamin D, many dermatologists still advocate the use of sunscreen to avoid skin damage. We also obtain some Vitamin D from our diet. Since few foods naturally contain the vitamin, many foods are fortified with Vitamin D. For people who cannot get enough Vitamin D, supplements are available in the form of vitamins D2 and D3. Vitamin D2 is produced in plants and fungi while Vitamin D3 is produced in animals and humans. Foods such as fish, beef, cheese, egg yolks, and mushrooms contain natural Vitamin D. Many countries also fortify their milk supply, usually in the form of Vitamin D3. The human body's use of Vitamin D is highly systematic. After the body either absorbs or acquires Vitamin D, it is stored in fat cells until further use. When needed the liver and kidney transform the accumulated Vitamin D into the active form (calcitriol).

Vitamin D is an essential nutrient for the well-being of the human body. A renowned function of this vitamin is that it helps absorb and retain phosphorus and calcium; both nutrients are needed for bone development. Furthermore, studies show that Vitamin D can help combat cancer, control infections, and reduce inflammation. According to the National Institute of Health, most people do not intake enough Vitamin D thus causing diseases such as rickets and osteomalacia. Approximately 70 percent of the population in India, 40 percent in Europe, 24 percent in the U.S.A, and 37 percent in Canada is Vitamin D deficient. Maintaining equilibrium is key since a surplus of Vitamin D can cause toxicity leading to anorexia, weight loss, and damage to the kidney and the heart. The daily Vitamin D intake for most people is around 600-800 IU (International Unit) per day.

As shown previously, Vitamin D is an important nutrient with many functions that help the human body operate smoothly. One main function of Vitamin D is its role as an immunomodulator hormone. Immunomodulators are drugs that target different pathways to treat diseases. This along with Vitamin D's established reputation in combating upper respiratory infections prompted scientists to study links between Vitamin D and Covid-19. The Coronavirus Disease 2019 (Covid-19) is currently a major pandemic causing health threats in countries around the globe. Many countries have issued a state of emergency and lockdowns to prevent the spread of the disease. Covid-19 is a contagious virus that most often causes respiratory problems but can harm the whole body. Some symptoms include fever, cough, loss or taste of smell, fatigue, etc. Most people with the disease have experienced mild to severe symptoms varying from person to person. As of August 2021, there have been about 200 million cases worldwide. As information about Covid-19 grows, many scientists believe that

Vitamin D may have connections with the virus. Researchers Mradul Mohan, Jerin Cherian, and Amit Sharma published an article regarding this topic: "Exploring links between vitamin D deficiency and COVID-19."

Before exploring the links, the researchers first had to acquaint themselves with the background information. They learned more about the coronavirus and vitamin D and formed two critical questions: "[Is there] an association between vitamin D deficiency and susceptibility to Coronavirus Disease 2019?" and "can vitamin D administration to deficient individuals prevent infection or alter the course of disease severity?" The researchers discovered that severe Covid-19 cases have connections to immune dysregulation and since Vitamin D is an immunomodulator the virus may be affected by the latter. Also, the researchers observed that low levels of Vitamin D adversely impacted patients with the virus. Some people with low Vitamin D levels had more severe Covid-19 cases than people with normal levels. Although there is a correlation between Vitamin D deficiency and Covid-19, the researchers do not promote Vitamin D use for treatment against the virus, instead stating that more research is needed.

Findings like this are important since they open new possibilities and paths leading to the broadening of information. This research may help others looking for improved coronavirus treatment. This study was greatly interesting to me as the Covid-19 pandemic is a recent event that has forced everyone to change. If I were a scientist, I would perform a case-control study to bring forth more evidence to verify and enhance the claims made by the researchers. This research is just some of the many ways Vitamin D affects us. Learning about the different vitamins and implementing them throughout your diet will help you in the long run.

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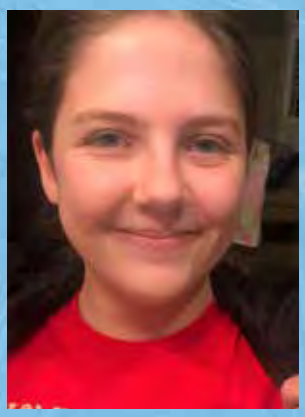

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Selenium: More Important Than One Would Think

Selenium, the 34th element in the periodic table, is one of the lesser-known elements. Sometimes called "red sulfur," its name originated from the Greek word 'selene,' meaning moon. Selenium exists in two forms; the inorganic form is selenate and selenite, and the organic form is selenomethionine and selenocysteine (Harvard T.H. Chan School of Public Health). Selenite and selenate are naturally found in soil and eventually are absorbed by plants and animals to create selenomethionine and selenocysteine. People then consume these plants and animals and gain their intake of selenium. Selenium was discovered by Jöns Jacob Berzelius in 1817 and was first observed in the bottom of a vat where sulfuric acid was made. It first appeared as red-brown sediment and shared many characteristics of sulfur (surprise, surprise).

At first, it was quite difficult to see that the element that had been discovered was a new element, as it shared many properties with tellurium. What separated the two elements was that when selenium is burned, it gives off a potent smell of radishes. Furthermore, it can be absorbed through the skin to give the person working with the element garlic breath (Royal Society of Chemistry). Of course, there are still many positive effects of selenium on the body. According to the United States National Library of Medicine, selenium helps the body produce antioxidant enzymes that prevent cell damage. It also helps protect the body from the poisonous effects of heavy metals on the body. Selenium has been shown to counteract the effects of inorganic mercury, as well as silver, to a limited extent (Whanger).

The recommended intake of selenium for people ages 14-18 is 55 mcg daily. Most Americans are able to receive enough selenium through their diet, especially if they consume food from areas where the soil is rich in selenium. Of course, some people struggle to meet the recommended selenium intake; for example, people with HIV or kidney dialysis are less likely to match the recommended consumption (National Institute of Health). While selenium deficiency is pretty rare in the United States, it does still exist in other countries. Selenium deficiency can cause Keshan disease, a heart disease in which the myocardium, the muscular wall of the heart, begins to deteriorate, leading to heart attacks and congestive heart failure (Liu, et al.). The disease was first reported in China's Keshan County in 1935, which has since been proven to be related to the selenium deficiency in the soil.

Selenium is mostly absorbed in the small intestine by active transport across cell membranes. Most selenium in the body is stored in a person's muscle tissue, but you can find the highest concentrations of selenium in the thyroid glands, which use selenium to assist with thyroid function (Mehdi, et al.). The body does not produce selenium, meaning that you must get your daily selenium intake from a balanced diet. Selenium also plays a major role in metabolism in the body. Because selenium is so prevalent in the thyroid, which is used to produce metabolic hormones, selenium has a large impact on the metabolic function in your body, like calories burned, etc (Climan). Selenium is found naturally in foods and rarely needs to be added because of the wide range of foods eaten by most people. It can be taken as a supplement, but only for short periods of time in low doses. If you take it for too long or at too high a dose (over 400 mcg) there is a severe risk of developing selenium toxicity which can make you sick and lead to extreme health conditions.

Selenium has been used in things other than food, however. The first solid-state solar

cells, used in solar panels, were composed of selenium (Hadar et al.). Selenium is very good at absorbing solar rays while maintaining a stable temperature for a while, which is helpful in maintaining environmental stability. Selenium is also cheap and can be easily manipulated into smaller shapes that function the same as the larger product. Although it isn't as great at converting sunlight into electricity as silicon wafers, it was the original solar panel composition and paved the path for new improvements (Hanley). It was also used to produce a purple-pinkish hue on glass in the mid-1900s. Because selenium produced such a soft pink color, it would often be used as a decolorizer to offset certain colors that would show up because of the chemical composition of the glass coloring (Corning Museum of Glass).

A recent research article that has interested me is "Recent advances in clinical studies of selenium supplementation in radiotherapy" by Emi Handa, Irma M Puspitasari, Rizky Abdulah, Chiho Yamazaki, Satomi Kameo, Takashi Nakano, and Hiroshi Koyama. This study looked at how selenium could be used to reduce the side effects in radiotherapy for cancer patients. The researchers "explored the benefits and risks of selenium supplementation in radiotherapy" (Handa, et al.). This article sought to expand upon the knowledge already available and update the work with more findings. The researchers reviewed past articles and identified 8 articles they could compare their findings to see if any research had differed. The results of the analysis showed that selenium supplementation offered benefits for several cancers treated with radiotherapy (Handa, et al.). The researchers came to the conclusion that if doctors were to check the selenium status of a patient and adequately adjust the levels accordingly, this would be more beneficial to the patient's overall health. This study is important because as we continue to develop new ways to treat different cancers, we still want to maintain safety and protect the health of the patients as much as possible. This article was especially important to me because my uncle is currently fighting brain cancer and seeing new ideas for restitching DNA and helping heal the body is always interesting to delve deeper into. I feel that the next experiment I would want to perform with selenium would be to see if selenium supplementation has any effect on healing damaged nerves or systems in the body.

Although selenium is one of the lesser-known elements, that doesn't make it any less important. Selenium is used to produce metabolic hormones, which your body uses to stay alive and helps the body produce antioxidant enzymes that help protect the cells. Furthermore, it has multiple uses outside of the body, like in solar panels and stained glass. Selenium truly does not receive all the credit that it's due, which is a shame.

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Magnesium

Magnesium is a vital macronutrient that sustains many human body processes. There are various forms of magnesium such as magnesium citrate (magnesium combined with citric acid), magnesium oxide (certain salt merged with magnesium and oxygen), magnesium lactate (a salt formed when magnesium merges with lactic acid), and several other types of magnesium. Magnesium is considered to be the fourth most copious mineral in the body. Additionally, magnesium takes part in more than 300 metabolic reactions, which are fundamental for human wellbeing. Not only is magnesium beneficial for humans, but the nutrient also aids in sustaining plant life. Chlorophyll is a certain chemical that provides plants with the ability to capture sunlight. Chlorophyll contains a magnesium ion. Without magnesium, photosynthesis would not be able to work. Joseph Black, a Scottish chemist was first to discover magnesium as an element in 1755. Nearly fifty years later, chemist Humphrey Davy acquired the metal and isolated it in pure state. Many researchers believe magnesium is instrumental toward reducing major depression. The first report of this possible finding was originated in 1921. 220 out of 250 subjects were successfully treated out of their depression from magnesium intake. Since then, there have been several more experiments in which magnesium has proven to diminish and fully terminate major depression. George Eby, a researcher from Austin, Texas, believes magnesium should be prescribed to treat and prevent major depression.

Magnesium is essential in ensuring our body is balanced by controlling muscle and nerve work, glucose levels, blood pressure, creating protein and DNA, as well as strengthening our bones. Magnesium aids in maintaining a healthy immune system because of the nutrient's antioxidant properties. The nutrient assists in the movement of blood sugar into muscles, and the disposal of lactate, which can develop during activity and cause tiredness. Magnesium improves energy levels, and some studies believe magnesium can even enhance physical performance. While research in this area is lacking, experts believe magnesium has psychological benefits as well. It is possible that inadequate supply of magnesium can be related to depression and other mental illnesses. Magnesium has anti-inflammatory benefits that can prevent aging, obesity, and disease. Furthermore, there is much evidence that magnesium improves premenstrual syndrome (PMS).

Magnesium consumption differs based on sex and age. The National Institutes of Health's Office of Dietary Supplements advises an adult male to ingest 400 to 420 milligrams of magnesium daily. However, female adults should consume 310 to 320 mg daily.

Magnesium deficiency results in fatigue, vomiting, loss of appetite, and weakness. More severe symptoms include seizures, irregular heart rhythm, and death. Lack of magnesium can result in a collection of glucose in blood, which will lead to type 2 diabetes. An inadequate supply of magnesium can increase the risk of high blood pressure and heart disease. Those with a healthy supply of magnesium have an increased bone mineral density, which lessens bone fractures and osteoporosis. Many researchers believe insufficient amounts of magnesium can result in osteoporosis. An overdose of magnesium is quite rare, but in large quantities, magnesium can be extremely unsafe. Side effects include low blood pressure, lethargy, cardiac arrest, shortness of breath, coma, unsteady heart rhythm, and death. Magnesium carbonate, magnesium chloride, magnesium gluconate, and magnesium oxide are most likely to instigate these symp-

toms. 5,000 mg of magnesium per day will result in magnesium toxicity. Individuals with kidney failure can possibly intake too much magnesium, as kidneys void an oversupply of magnesium from the body.

Magnesium is mainly stored in the small intestine by a saturable transport system as well as passive diffusion. Some of the magnesium can be found in the large intestine as well. A small portion of magnesium is transferred through transitory receptors. The absorption of magnesium relies upon the magnesium status rather than intake. With a normal intake of magnesium, roughly 30-40% is absorbed. The smaller the magnesium level is the larger absorption of magnesium will result and vice versa. Kidneys are necessary in maintaining magnesium balance. A fraction of magnesium is excreted in urine, while the rest of magnesium is then reabsorbed through the proximal tube. 99 percent of the magnesium found in the body is contained in bones, muscles, and tissues. 50 to 60 percent of magnesium in the body is stores in the hydroxyapatite surface of bones and teeth. The remaining magnesium is kept in tissue and muscles. One percent of magnesium is found in red blood cells. In times of magnesium deficiency, the body will collect the magnesium stored in red blood cells.

The human body does not naturally produce magnesium. Foods such as nuts, seeds, grains, green vegetables, dairy products, beans, peas, and lentils all contain magnesium. Magnesium is added in bottled waters to enhance taste. Cereal is a popular, fortified food in which magnesium is added to make the cereal more nutritious. Magnesium oxide is used to prevent lumping in baking. Magnesium Sulfate is used as an additive to intensify the firmness of canned goods. Magnesium is available as a supplement in the forms of magnesium oxide, magnesium chloride, magnesium citrate, and more. Magnesium that is more soluble in water will be more absorbed by the small intestine. Magnesium aspartate, chloride, citrate, and lactate are absorbed more than magnesium oxide and magnesium sulfate. The nutrient is also found in various medicines. Laxatives and medicines for heartburn will most likely contain magnesium.

Researchers have studied whether magnesium oxide is efficient in ridding the skin of calcium deposits in subjects with Pseudoxanthoma Elasticum (PXE). The study was double blind and included a placebo. Subjects were given a starting dose of 100 mg of magnesium daily. From there, subjects were then evaluated through blood tests, skin biopsies, eye examinations, bone density tests, and photos of skin lesions. Overall, the blinded researchers did find magnesium to be successful in maintaining calcium deposits in subjects with PXE. After a year, a dermatopatholigst assessed Von Kassa stains to detect the amount of calcium in the dermis. At the end of the study, photographs were collected of skin lesions, and there was a significant change from the start of the trial. Ophthalmologic examinations determined whether magnesium improved the disease. The researchers' discovery is quite important, as PXE has no official cure. However, magnesium oxide can be used to regulate the spread of this disease.

This study is interesting to me because I have a skin condition as well. Though not as severe as PXE, I have yet to have found a cure that is completely effective. I have noticed certain changes in my diet and Vitamin D supplements have improved my condition drastically. As a scientist, I would have furthered my study by including more subjects. I would have also considered using magnesium citrate, as it is more bioavailable. Lastly, I would carefully mark magnesium status in patients to ensure there is no overdosage.

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