Chequers Academy

Vitamin IV Infusions

General Information about vitamins available as infusions

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Understanding Intravenous (IV) Vitamin Drips

Intravenous (IV) vitamin drips were pioneered by Dr. John Myers in the 1970s, resulting in the creation of the Myers' Cocktail. These infusions typically take between 20 to 60 minutes to administer and deliver a concentrated dose of vitamins directly into the bloodstream. Unlike oral ingestion, where vitamins are partially broken down in the digestive tract (resulting in approximately 20% absorption), IV delivery allows for approximately 90% absorption of vitamins.

IV nutrient absorption bypasses the digestive system, ensuring rapid uptake and higher levels of vitamins and minerals in the body compared to oral intake from food or supplements. Factors such as age, metabolism, health status, genetics, and interactions with medications can hinder nutrient absorption through oral means.

Higher concentrations of vitamins and minerals in the bloodstream are believed to enhance cellular uptake, potentially supporting overall health and combating illnesses. The benefits of IV therapy extend to various health concerns, with conditions such as asthma, migraines, chronic fatigue syndrome, fibromyalgia, muscle spasms, pain, allergies, and respiratory infections responding positively to Myers' Cocktail treatment.

Applications of IV Therapy:

- Restoring and maintaining fluid and electrolyte balance
- Delivering parenteral nutrients and supplements

Benefits of IV Therapy:

- Efficient delivery method when oral intake is impractical
- Prevention of oxidative damage
- Anti-aging effects
- Enhancement of hair, nail, skin, and eye health
- Skin clarity improvement and reduction in blemishes
- Diminishing appearance of wrinkles
- Rebalancing electrolytes after intense physical activity
- Strengthening immune response for cold prevention and post-illness recovery

Considerations:

Despite its benefits, IV therapy carries risks like bleeding, vascular damage, fluid overload, tissue infiltration, infection, rapid drug response leading to overdose, solution compatibility issues, and allergic reactions to infused substances.

In conclusion, IV vitamin drips provide a direct and effective means of nutrient supplementation and therapy, offering potential benefits across a spectrum of health conditions. However, careful consideration of individual health factors and monitoring for adverse effects are essential in optimizing safety and effectiveness.

Understanding Vitamins

Water Soluble and Fat-Soluble Vitamins

- Vitamins can be classified based on their solubility.

- Most are water-soluble, meaning they dissolve in water. In contrast, the fat-soluble vitamins are similar to oil and do not dissolve in water.

- Fat-soluble vitamins are most abundant in high-fat foods and are much better absorbed into your bloodstream when you eat them with fat.

- There are four fat-soluble vitamins in the human diet:
    - Vitamin A
    - Vitamin D
    - Vitamin E
    - Vitamin K

Vitamin A

Vitamin A plays a key role in maintaining your vision. Without it, you would go blind.

Types

- Vitamin A is not a single compound. Rather, it is a group of fat-soluble compounds collectively known as retinoids.

- The most common dietary form of vitamin A is retinol. Other forms — retinal and retinoic acid — are found in the body, but absent or rare in foods.

- Vitamin A2 (3,4-dehydroretinal) is an alternative, less active form found in freshwater fish.

Role and Function of Vitamin A

Vitamin A supports many critical aspects of body function, including:

- **Vision maintenance:** Vitamin A is essential for maintaining the light-sensing cells in the eyes and for the formation of tear fluid.
- **Immune function:** Vitamin A deficiency impairs immune function, increasing susceptibility to infections.
- **Body growth:** Vitamin A is necessary for cell growth. Deficiency may slow or prevent growth in children.
- **Hair growth:** It is also vital for hair growth. Deficiency leads to alopecia, or hair loss.
- **Reproductive function:** Vitamin A maintains fertility and is vital for fetal development.

Dietary Sources

- Vitamin A is only found in animal-sourced foods. The main natural food sources are liver, fish liver oil and butter.
- Vitamin A can also be derived from certain carotenoid antioxidants found in plants. They are collectively known as provitamin A.
- The most efficient of these is beta-carotene, which is abundant in many vegetables, such as carrots, kale and spinach.

Vitamin A Deficiency

- Vitamin A deficiency is rare in developed countries.
- However, vegans may be at risk, since pre-formed vitamin A is only found in animal-sourced foods.

- Although pro-vitamin A is abundant in many fruits and vegetables, it is not always efficiently converted into retinol, the active form of vitamin A. The efficiency of this conversion depends on people's genetics.

- Deficiency is also widespread in some developing countries where food variety is limited. It is common in populations whose diet is dominated by refined rice, white potatoes or cassava and lacking in meat, fat and vegetables.

- A common symptom of early deficiency includes night blindness. As it progresses, it may lead to more serious conditions, such as:
    - Dry eyes: Severe deficiency may cause xerophthalmia, a condition characterised by dry eyes caused by reduced tear fluid formation.
    - Blindness: Serious vitamin A deficiency may lead to total blindness. In fact, it is among the most common preventable causes of blindness in the world.
    - Hair loss: A vitamin A deficiency, may lead to hair loss.
    - Skin problems: Deficiency leads to a skin condition known as hyperkeratosis or goose flesh.
    - Poor immune function: Poor vitamin A status or deficiency makes people prone to infections.

Vitamin A Toxicity

- Overdosing on vitamin A leads to an adverse condition known as hypervitaminosis A. It's rare but may have serious health effects.

- Its main causes are excessive doses of vitamin A from supplements, liver, or fish liver oil. In contrast, high intake of provitamin A does not cause hypervitaminosis.

- The main symptoms and consequences of toxicity include fatigue, headache, irritability, stomach pain, joint pain, lack of appetite, vomiting, blurred vision, skin problems and inflammation in the mouth and eyes.

- It may also lead to liver damage, bone loss and hair loss. At extremely high doses, vitamin A can be fatal.

- People are advised to avoid exceeding the upper limit for intake, which is 10,000 IU (900 mcg) per day for adults.

- Higher amounts, or 300,000 IU (900 mg), may cause acute hypervitaminosis A in adults. Children can experience harmful effects at much lower amounts.

- Individual tolerance varies considerably. Children and people with liver diseases like cirrhosis and hepatitis are at an increased risk and need to take extra care.

- Pregnant women should also be especially careful, since high doses of vitamin A may harm the fetus. Doses as low as 25,000 IU per day have been linked with birth defects.

Vitamin D

- Nicknamed the sunshine vitamin, vitamin D is produced by the skin when it's exposed to sunlight.

- It is best known for its beneficial effects on bone health, and deficiency making them highly susceptible to fractures.

Types

Vitamin D is a collective term used to describe a few related fat-soluble compounds. Also known as calciferol, vitamin D comes in two main dietary forms:

- **Vitamin D2 (ergocalciferol):** Found in mushrooms and some plants.
- **Vitamin D3 (cholecalciferol):** Found in animal-sourced foods, such as eggs and fish oil, and produced by your skin when exposed to sunlight.

Role and Function of Vitamin D

- Vitamin D has numerous roles and functions, but only a few are well researched. These include the following:
    - **Bone maintenance:** Vitamin D regulates the circulating levels of calcium and phosphorus, which are the most important minerals for bone growth and maintenance. It promotes the absorption of these minerals from the diet.
    - **Immune system regulation:** It also regulates and strengthens immune system function.
- Once absorbed into the bloodstream, the liver and kidneys change calciferol into calcitriol, which is the biologically active form of vitamin D. It can also be stored for later use in the form of calcidiol.
- Vitamin D3 is more efficiently converted into calcitriol than vitamin D2.

Sources of Vitamin D

- The body can produce all the vitamin D it needs as long as the skin is regularly exposed to sunlight.

- However, many people spend little time in the sun or do so fully clothed. Justifiably, others cover their skin with sunscreen to prevent sunburns. While sunscreen use is highly recommended, it reduces the amount of vitamin D produced by the skin.

- As a result, people generally need to rely on their diets to get enough vitamin D.

- Few foods naturally contain vitamin D. The best dietary sources are fatty fish and fish oil, but mushrooms that have been exposed to ultraviolet light may also contain significant amounts.

- In addition, dairy products and margarine often come with added vitamin D.

Vitamin D Deficiency

- Severe vitamin D deficiency is rare, but mild forms of deficiency or insufficiency are common among hospitalised people as well as the elderly.

- Risk factors of deficiency are highly pigmented skin, old age, obesity, low sun exposure and diseases that impair fat absorption.

- The most well-known consequences of vitamin D deficiency include soft bones, weak muscles and an increased risk of bone fractures. This condition is called osteomalacia in adults and rickets in children.

- Vitamin D deficiency is also associated with poor immune function, an increased susceptibility to infections and autoimmune diseases.

- Other signs of deficiency or insufficiency may include fatigue, depression, hair loss and impaired wound healing.

- Observational studies have also linked low vitamin D levels or deficiency with an increased risk of dying from cancer and an elevated risk of heart attacks.

Vitamin D Toxicity

- Vitamin D toxicity is very rare.

- While spending a lot of time in the sun doesn't cause vitamin D toxicity, taking high amounts of supplements may cause harm.

- The main consequence of toxicity is hypercalcemia, a condition characterised by excessive amounts of calcium in the blood.

- Symptoms include headache, nausea, lack of appetite, weight loss, fatigue, kidney and heart damage, high blood pressure and fetal abnormalities.

- People are generally advised to avoid exceeding the upper limit of vitamin D intake, which is 4,000 IU per day for adults.

- Higher amounts, ranging from 40,000–100,000 IU (1,000–2,500 mcg) per day, may cause symptoms of toxicity in adults when taken daily for one or two months. Keep in mind that much lower doses may harm young children.

Vitamin E

As a powerful antioxidant, vitamin E protects the body's cells against premature ageing and damage by free radicals.

Types

Vitamin E is a family of eight structurally similar antioxidants that are divided into two groups:

- **Tocopherols:** Alpha-tocopherol, beta-tocopherol, gamma-tocopherol and delta-tocopherol.
- **Tocotrienols:** Alpha-tocotrienol, beta-tocotrienol, gamma-tocotrienol and delta-tocotrienol.

Alpha-tocopherol is the most common form of vitamin E. It makes up around 90% of the vitamin E in the blood.

Role and Function of Vitamin E

- Vitamin E's main role is to act as an antioxidant, preventing oxidative stress and protecting fatty acids in the cell membranes from free radicals.
- These antioxidant properties are enhanced by other nutrients, such as vitamin C, vitamin B3 and selenium.
- In high amounts, vitamin E also acts as a blood thinner, reducing the blood's ability to clot.

Dietary Sources

- The richest dietary sources of vitamin E include certain vegetable oils, seeds, and nuts.

- Other rich sources include avocados, peanut butter, margarine, fatty fish and fish liver oil.

Vitamin E Deficiency

- Vitamin E deficiency is uncommon and is never detected in people who are otherwise healthy.

- It happens most often in diseases that impair the absorption of fat or vitamin E from food, such as cystic fibrosis and liver disease.

- Symptoms of vitamin E deficiency include muscle weakness, walking difficulties, tremors, vision problems, poor immune function, and numbness.

- Severe, long-term deficiency may lead to anaemia, heart disease, serious neurological problems, blindness, dementia, poor reflexes, and the inability to fully control body movements.

Vitamin E Toxicity

- Overdosing on vitamin E is difficult when it is obtained from natural dietary sources. Cases of toxicity have only been reported after people have taken very high doses of supplements.

- Yet, compared to vitamin A and D, overdosing on vitamin E appears to be relatively harmless.

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- It may have blood-thinning effects, counteracting the effects of vitamin K and causing excessive bleeding. Thus, people who take blood-thinning medications should avoid taking large doses of vitamin E.

- Additionally, at high doses of more than 1,000 mg per day, vitamin E may have pro-oxidant effects. That is, it can become the opposite of an antioxidant, potentially leading to oxidative stress.

Vitamin K

Vitamin K plays a key role in blood clotting. Without it, you would run the risk of bleeding to death.

Types

Vitamin K is actually a group of fat-soluble compounds divided into two main groups:

- **Vitamin K1 (phylloquinone):** Found in plant-sourced foods, phylloquinone is the main form of vitamin K in the diet.
- **Vitamin K2 (menaquinone):** This variety of vitamin K is found in animal-sourced foods and fermented soy products, like natto. Vitamin K2 is also produced by gut bacteria in the colon.

Additionally, there are at least three synthetic forms of vitamin K. These are known as vitamin K3 (menadione), vitamin K4 (menadiol diacetate) and vitamin K5.

Role and Function of Vitamin K

- Vitamin K plays an essential role in blood clotting. In fact, the "K" stands for "koagulation," the Danish word for coagulation, which means clotting.

- But vitamin K has other functions as well, including supporting bone health and helping prevent the calcification of blood vessels, potentially reducing the risk of heart disease.

Dietary Sources

- The best dietary sources of vitamin K1 (phylloquinone) are leafy green vegetables, whereas vitamin K2 (menaquinone) is mainly found in animal-sourced foods and fermented soy products.

- In contrast to phylloquinone, menaquinone is only found in small amounts in certain high-fat, animal-sourced foods, such as egg yolks, butter and liver.

- It is also found in certain soy foods, such as natto.

Vitamin K Deficiency

- Unlike vitamins A and D, vitamin K isn't stored in the body in significant amounts. For this reason, consuming a diet lacking in vitamin K may lead to deficiency in as little as a week.
- People who do not efficiently digest and absorb fat are at the greatest risk of developing vitamin K deficiency. This includes those who suffer from celiac disease, inflammatory bowel disease and cystic fibrosis.

- Use of broad-spectrum antibiotics may also raise the risk of deficiency, as well as very high doses of vitamin A, which seem to reduce vitamin K absorption.

- Mega-doses of vitamin E may also counteract the effects of vitamin K on blood clotting.

- Without vitamin K, the blood wouldn't clot and even a small wound could cause unstoppable bleeding.

- Fortunately, vitamin K deficiency is rare, since the body only needs small amounts to maintain blood clotting.

- Low levels of vitamin K have also been linked with reduced bone density and increased risk of fractures in women.

Vitamin K Toxicity

- Unlike the other fat-soluble vitamins, natural forms of vitamin K have no known symptoms of toxicity.

- As a result, scientists have not been able to establish a tolerable upper intake level for vitamin K. Further studies are needed.

- In contrast, a synthetic form of vitamin K, known as menadione or vitamin K3, may have some adverse effects when consumed in high amounts.

Water Soluble Vitamins

Nine water-soluble vitamins are found in the human diet:

- Vitamin B1 (thiamine)
- Vitamin B2 (riboflavin)
- Vitamin B3 (niacin)
- Vitamin B5 (pantothenic acid)
- Vitamin B6
- Vitamin B7 (biotin)
- Vitamin B9
- Vitamin B12 (cobalamin)
- Vitamin C

Unlike the fat-soluble vitamins, water-soluble vitamins are generally not stored in the body. For this reason, you should try to get them regularly from your diet.

Thiamine (Vitamin B1)

Thiamine, also known as vitamin B1, was the first water-soluble vitamin to be described scientifically.

Types

Many forms of thiamine exist, including:

- **Thiamine pyrophosphate:** Also known as thiamine diphosphate, thiamine pyrophosphate is the most abundant form of thiamine in the body. It is also the main form found in whole foods.
- **Thiamine triphosphate:** This form is found in animal-sourced foods but is less abundant than thiamine pyrophosphate. It is believed to represent less than 10% of the total thiamine found in animal tissues.

- **Thiamine mononitrate:** A synthetic form of thiamine often added to animal feed or processed food.
- **Thiamine hydrochloride:** The standard, synthetic form of thiamine used in supplements.

Role and Function

- Like the other B vitamins, thiamine serves as a coenzyme in the body. This applies to all its active forms, but thiamine pyrophosphate is the most important one.

- Coenzymes are small compounds that help enzymes trigger chemical reactions that otherwise wouldn't happen on their own.

- Thiamine is involved in many essential chemical reactions. For instance, it helps convert nutrients into energy and supports sugar formation.

Dietary Sources

The richest dietary sources of thiamine include nuts, seeds, whole grains, liver, and pork.
In contrast, fruits, vegetables, and dairy products generally do not provide much thiamine.

Thiamine Deficiency

- Deficiency is uncommon, but high blood sugar levels may increase thiamine elimination via urine, raising its requirements and the risk of deficiency. In fact, thiamine levels may be reduced by 75–76% in people with type 1 and type 2 diabetes.

- People with alcoholism are also at an increased risk for deficiency because of a poor diet and impaired thiamine absorption.

- Serious deficiency may lead to disorders known as beriberi and Wernicke-Korsakoff syndrome.

- These disorders are associated with a range of symptoms, including anorexia, weight loss, impaired neural function, mental problems, muscle weakness and heart enlargement.

Side Effects and Toxicity

- Thiamine is considered safe. There are no reports of adverse effects after the intake of high amounts of thiamine from food or supplements.

- This is partly because excess thiamine is quickly excreted from the body in urine.

- As a result, the tolerable upper intake level for thiamine has not been established. However, this does not rule out possible symptoms of toxicity at very high intakes.

Riboflavin (Vitamin B2)

Riboflavin is the only water-soluble vitamin used as a food colouring. In fact, it is named for its colour — the Latin word *flavus* means "yellow."

Types

- In addition to riboflavin, dietary substances known as flavoproteins release riboflavin during digestion.

- Two of the most common flavoproteins are flavin adenine dinucleotide and flavin mononucleotide. They are found in a wide range of foods.

Role and Function

- Riboflavin functions as a coenzyme in various chemical reactions.

- Like thiamine, it is involved in the conversion of nutrients into energy. It is also required in the conversion of vitamin B6 to its active form, and in the conversion of tryptophan to niacin (vitamin B3).

Dietary Sources

- Dietary sources include lamb, beef and pork liver, hard goat cheese and almonds.

- Yeast extract spread is also exceptionally rich in riboflavin, containing around 18 mg in every 100 grams. Other good sources of riboflavin include eggs, leafy vegetables, broccoli, milk, legumes, mushrooms and meat.

- Additionally, riboflavin is often added to processed breakfast cereals and is used as a yellow-orange food colouring.

Deficiency

- Riboflavin deficiency is very rare in developed countries. However, a poor diet, old age, lung diseases and alcoholism may increase the risk.

- Severe deficiency results in a condition known as ariboflavinosis, which is characterised by a sore throat, inflamed tongue, anaemia, as well as skin and eye problems.

- It also impairs the metabolism of vitamin B6 and the conversion of tryptophan to niacin.

Side Effects and Toxicity

- High intake of dietary or supplemental riboflavin has no known effects of toxicity.
- Absorption becomes less efficient at higher doses. Also, very small amounts are stored in body tissues and excess riboflavin is flushed out of the body with urine.
- As a result, the safe upper intake level of riboflavin has not been established.

Niacin (Vitamin B3)

Niacin, also known as vitamin B3, is the only B vitamin your body can produce from another nutrient — the amino acid tryptophan.

Types

Niacin is a group of related nutrients. The most common forms are:

- **Nicotinic acid:** The most common form in supplements. Also found in both plant- and animal-sourced foods. High-dose nicotinic acid supplements may cause a condition called niacin flush.
- **Nicotinamide (niacinamide):** Found in supplements and foods.

The compound nicotinamide riboside also has vitamin B3 activity. It is found in trace amounts in whey protein and baker's yeast.

Role and Function

- All dietary forms of niacin are eventually converted into nicotinamide adenine dinucleotide (NAD+) or nicotinamide adenine dinucleotide phosphate (NADP+), which act as coenzymes.

- Like the other B vitamins, it functions as a coenzyme in the body, playing an essential role in cellular function and acting as an antioxidant.

- One of its most important roles is to drive a metabolic process known as glycolysis, the extraction of energy from glucose (sugar).

Dietary Sources

- Niacin is found in both plants and animals.

- Yeast extract spread is exceptionally rich in niacin, providing around 128 mg in every 100 grams.

- Other good sources include fish, chicken, eggs, dairy products, and mushrooms. Niacin is also added to breakfast cereals and flour.

- Additionally, the body can synthesise niacin from the amino acid tryptophan. Scientists have estimated that 60 mg of tryptophan can be used to create 1 mg of niacin.

Niacin Deficiency

- Niacin deficiency, known as pellagra, is uncommon in developed countries.

- The main symptoms of pellagra include inflamed skin, mouth sores, diarrhoea, insomnia, and dementia. Like all deficiency diseases, it is fatal without treatment.

- Fortunately, you can easily get all the niacin you need from a varied diet.

- Deficiency is much more common in developing countries where people commonly follow diets that lack diversity.

- Cereal grains are especially low in available niacin since most of it is bound to fibre in the form of niacytin.

- However, the body can synthesise it from the amino acid tryptophan. As a result, severe niacin deficiency can often be avoided on a high-protein diet.

Side Effects and Toxicity

- Naturally occurring niacin from food does not appear to have any adverse effects.

- However, high supplemental doses of niacin may cause niacin flush, nausea, vomiting, stomach irritation and liver damage.

- Niacin flush is a side effect of immediate-release nicotinic acid supplements. It is characterised by a flush in the face, neck, arms and chest.

- Liver damage is associated with the long-term use of very high doses (3–9 grams per day) of sustained-release or slow-release nicotinic acid.

- Additionally, taking niacin supplements for a long time may increase insulin resistance and raise blood sugar levels.

- Nicotinic acid may also increase the circulating levels of uric acid, worsening symptoms in people who are predisposed to gout.

Pantothenic Acid (Vitamin B5)

- Pantothenic acid is found in virtually all food. Appropriately, its name is derived from the Greek word *pantothen*, which means “from every side.”

Types

- There are multiple forms of pantothenic acid or compounds that release the active form of the vitamin when digested. In addition to free pantothenic acid, these include:
    - **Coenzyme A:** A common source of this vitamin in foods. It releases pantothenic acid in the digestive tract.
    - **Acyl carrier protein:** Like coenzyme A, acyl carrier protein is found in foods and releases pantothenic acid during digestion.
    - **Calcium pantothenate:** The most common form of pantothenic acid in supplements.
    - **Panthenol:** Another form of pantothenic acid often used in supplements.

Role and Function

- Pantothenic acid plays a key role in a wide range of metabolic functions.

- It is required for the formation of coenzyme A, which is necessary for the synthesis of fatty acids, amino acids, steroid hormones, neurotransmitters, and various other important compounds.

Dietary Sources

- Pantothenic acid is found in virtually all food. The main sources include; Beef & lamb liver, sunflower seeds, trout and portobello mushrooms.

- Other rich sources include yeast extract spread, shiitake mushrooms, caviar, kidneys, chicken, beef, and egg yolks.

- Several plant foods are also good sources. In addition to those mentioned above, these include root vegetables, whole grains, tomatoes, and broccoli.

- Like many other B vitamins, pantothenic acid is often added to breakfast cereals.

Deficiency

- Pantothenic acid deficiency is rare in industrialised countries. In fact, this vitamin is so widespread in foods that deficiency is virtually unheard of, except in severe malnutrition.

- However, its requirements may be higher in people with diabetes and those who regularly consume excessive amounts of alcohol.

- Studies in animals show that pantothenic acid deficiency has an adverse impact on most organ systems. It is associated with numerous symptoms, including numbness, irritability, sleep disturbances, restlessness, and digestive problems.

Side Effects and Toxicity

- Pantothenic acid does not appear to have any adverse effects at high doses. The tolerable upper limit has not been established.

- However, large doses like 10 grams per day may cause digestive discomfort and diarrhoea.

- In mice, the lethal dose was estimated to be around 4.5 grams for each pound of body weight (10 grams per kg), an amount equivalent to 318 grams for a 154-pound (70-kg) human.

Vitamin B6

- Vitamin B6 is a group of nutrients that are required for the synthesis of pyridoxal phosphate, a coenzyme involved in more than 100 different metabolic processes.

Types

- Like the other B vitamins, vitamin B6 is a family of related compounds, such as:
    - **Pyridoxine:** This form is found in fruits, vegetables, and grains, as well as supplements. Processed foods may also contain added pyridoxine.
    - **Pyridoxamine:** Used until recently in dietary supplements in the US. However, the FDA now considers pyridoxamine a pharmaceutical drug. Pyridoxamine phosphate is a common form of vitamin B6 in animal-sourced foods.
    - **Pyridoxal:** Pyridoxal phosphate is the main type of vitamin B6 in animal-sourced foods.
- In the liver, all dietary forms of vitamin B6 are converted into pyridoxal 5-phosphate, the active form of the vitamin.

Role and Function

- Like other B vitamins, vitamin B6 acts as a coenzyme in numerous chemical reactions.
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- It is involved in red blood cell formation as well as energy and amino acid metabolism.

- It is also required for the release of glucose (sugar) from glycogen, the molecule the body uses to store carbs.

- Vitamin B6 also supports the formation of white blood cells and helps the body synthesise several neurotransmitters.

Dietary Sources

- Vitamin B6 is found in a wide variety of foods. These include pistachio nuts, beef and lamb liver, salmon, and sunflower seeds.

- Other good sources include tuna, pork, turkey, bananas, chickpeas, and potatoes. Vitamin B6 is also added to breakfast cereals and soy-based meat substitutes.

- The availability of this vitamin is generally higher in animal-sourced foods, compared to plant foods.

Deficiency

- Vitamin B6 deficiency is rare. People with alcoholism are at the greatest risk.

- The main symptoms include anaemia, skin rashes, convulsions, confusion and depression.

- Deficiency has also been associated with an increased risk of cancer.

Side Effects and Toxicity

- Naturally occurring vitamin B6 from food does not seem to have any adverse effects.

- In contrast, very large supplemental doses of pyridoxine — 2,000 mg per day or more — are linked to sensory nerve damage and skin lesions.

- High intake of pyridoxine supplements may also suppress milk production in breastfeeding women.

Biotin (Vitamin B7)

People often take biotin supplements to nourish their hair, nails, and skin, although strong evidence for these benefits is lacking. In fact, it was historically called vitamin H after the German word *haut*, meaning “skin”.

Types

- Biotin is either found in its free form or bound to proteins.

- When proteins that contain biotin are digested, they release a compound called biocytin. The digestive enzyme biotinidase then breaks biocytin into free biotin and lysine, an amino acid.

Role and Function

- Same as all B vitamins, biotin functions as a coenzyme. It is required for the function of five carboxylases, enzymes involved in several fundamental metabolic processes.

- For instance, biotin serves an essential role in fatty acid synthesis, glucose formation and amino acid metabolism.

Dietary Sources

- Compared to the other B vitamins, biotin doesn't have as much research behind its content in food.

- Animal-sourced foods rich in biotin include organ meats, fish, meat, egg yolk and dairy products. Good plant sources include legumes, leafy greens, cauliflower, mushrooms, and nuts.

- The gut microbiota also produces small amounts of biotin.

Deficiency

- Biotin deficiency is relatively uncommon.

- The risk is greatest among infants who are fed formula low in biotin, people taking antiepileptic medications, infants with Leiner's disease or people who are genetically predisposed to deficiency.

- Untreated biotin deficiency can cause neurological symptoms, such as seizures, intellectual disability and loss of muscle coordination.

- Deficiency has also been reported in animals fed high amounts of raw egg whites. Egg whites contain a protein called avidin, which prevents the absorption of biotin.

Side Effects and Toxicity

- Biotin does not have any known adverse effects at high doses and the tolerable upper limit has not been established

Vitamin B9

- Vitamin B9 was first discovered in yeast, but later isolated from spinach leaves. For this reason, it was given the names folic acid or folate, words derived from the Latin word *folium*, meaning "leaf."

Types

- Vitamin B9 comes in several different forms, including:
    - **Folate:** A family of vitamin B9 compounds that naturally occurs in foods.
    - **Folic acid:** A synthetic form commonly added to processed foods or sold as a supplement. Some scientists are concerned that high-dose folic acid supplements may cause harm.
    - **L-methylfolate:** Also known as 5-methyltetrahydrofolate, L-methylfolate is the active form of vitamin B9 in the body. As a supplement, it is thought to be healthier than folic acid.

Role and Function

- Vitamin B9 acts as a coenzyme and is essential for cell growth, DNA formation and amino acid metabolism.

- It is very important during periods of rapid cell division and growth, such as in infancy and pregnancy.

- Additionally, it is required for the formation of red and white blood cells, so deficiency may lead to anaemia.

Dietary Sources

- The common sources of vitamin B9 include lamb liver, edamame, peanuts, raw spinach, and chickpeas.

- Other good sources include leafy greens, legumes, sunflower seeds and asparagus. Yeast extract spread is exceptionally rich in vitamin B9, providing around 3,786 mcg per 100 grams.

- Folic acid is also frequently added to processed food products.

Deficiency

- Vitamin B9 deficiency rarely occurs on its own. It is usually associated with other nutrient deficiencies and a poor diet.

- Anaemia is one of the classic symptoms of vitamin B9 deficiency. It is indistinguishable from the anaemia associated with vitamin B12 deficiency.

- Lack of vitamin B9 may also lead to birth defects of the brain or neural chord, collectively known as neural tube defects.

Side Effects and Toxicity

- No serious adverse effects of high vitamin B9 intake have been reported.

- Yet, studies show that high-dose supplements may mask vitamin B12 deficiency. Some even suggest that they may worsen the neurological damage associated with vitamin B12 deficiency.

- Additionally, some scientists are concerned that a high intake of folic acid — a synthetic form of vitamin B9 — may cause health problems.

Vitamin B12 (Cobalamin)

- Vitamin B12 is the only vitamin that contains a metallic element, namely cobalt. For this reason, it is often referred to as cobalamin.

Types

- There are four main types of vitamin B12 — cyanocobalamin, hydroxocobalamin, adenosylcobalamin and methylcobalamin.

- All of them can be found in supplements, although cyanocobalamin is the most common. It is considered ideal for supplements due to its stability but is only found in trace amounts in food.

- Hydroxocobalamin is the most common naturally occurring form of vitamin B12 and is widely found in animal-sourced foods.

- The other natural forms methylcobalamin and adenosylcobalamin have become popular as supplements in recent years.

Role and Function

- Like all other B vitamins, vitamin B12 acts as a coenzyme.

- Adequate intake helps maintain brain function and development, neurological function, and the production of red blood cells.

- It is also required for converting protein and fat into energy and is essential for cell division and DNA synthesis.

Dietary Sources

- Animal-sourced foods are virtually the only dietary sources of vitamin B12. These include meat, dairy products, seafood and eggs.

- Other rich sources include other types of liver, heart, octopus, oysters, herring, and tuna.

- However, tempeh and a few algae, such as nori seaweed, may also contain small amounts of vitamin B12.

- Whether these foods can provide sufficient amounts on their own is a matter of debate.

- Other algae, like spirulina, contain pseudovitamin B12, a group of compounds that are similar to vitamin B12, but unusable by the body.

Deficiency

- Vitamin B12 is stored in the liver, so even if you aren't getting enough of it, it may take a long time for deficiency symptoms to develop.

- Those who are at the greatest risk of deficiency are those who never or rarely eat animal-sourced foods. This includes vegetarians and vegans.

- Deficiency may also develop in older people. In fact, many require regular vitamin B12 injections.

- Vitamin B12 absorption depends on a protein produced by the stomach called intrinsic factor. As people age, the formation of intrinsic factor may reduce or stop altogether.

- Other risk groups include those who have had weight loss surgery or suffer from Crohn's disease or celiac disease.

- Deficiency may cause various health problems, such as anaemia, appetite loss, sore tongue, neurological problems, and dementia.

Side Effects and Toxicity

- Only a small proportion of vitamin B12 can be absorbed from the digestive tract. The amount absorbed depends on the production of intrinsic factor in the stomach.

- As a result, no adverse effects have been linked with high intake of vitamin B12 in healthy people. The tolerable upper intake level has not been established.

Vitamin C

- Vitamin C is the only water-soluble vitamin that doesn't belong to the vitamin B category. It is one of the body's main antioxidants and is required for collagen synthesis.

Types

- Vitamin C comes in two forms, the most common of which is known as ascorbic acid.

- An oxidised form of ascorbic acid called dehydroascorbic acid also has vitamin C activity.

Role and Function

- Vitamin C supports many essential body functions, including:
    - **Antioxidant defences:** Your body uses antioxidants to protect itself against oxidative stress. Vitamin C is one of its most important antioxidants.
    - **Collagen formation:** Without vitamin C, the body is unable to synthesise collagen, the main protein in connective tissue. As a result, deficiency affects the skin, tendons, ligaments and bones.
    - **Immune function:** Immune cells contain high levels of vitamin C. During an infection, its levels are quickly depleted.
- Unlike the B vitamins, vitamin C doesn't act as a coenzyme, although it is a cofactor for prolyl hydroxylase, an enzyme that serves an essential role in the formation of collagen.

Dietary Sources

- The main dietary sources of vitamin C are fruits and vegetables.
- Cooked animal-sourced foods contain virtually no vitamin C, but low amounts can be found in raw liver, eggs, fish roe, meat, and fish.
- Cooking or drying foods significantly reduces their vitamin C content.

Vitamin C Deficiency

- Deficiency is rare in Western countries but may develop in people who follow restrictive diets or eat almost no fruits or vegetables. People with drug addiction or alcoholism are also at greater risk.

- It leads to a disease known as scurvy, which is characterised by the breakdown of connective tissue.

- The first symptoms of deficiency include fatigue and weakness. As scurvy becomes worse, people may experience spotted skin and inflamed gums.

- Advanced scurvy may cause loss of teeth, bleeding gums and skin, joint problems, dry eyes, swelling and impaired wound healing. Like all vitamin deficiencies, scurvy is fatal without treatment.

Side Effects and Toxicity

- Most people tolerate high doses of vitamin C without any side effects.

- However, very high doses exceeding 3 grams per day cause diarrhoea, nausea and abdominal cramps. This is because only a limited amount of vitamin C can be absorbed from a single dose.

- Taking high-dose supplements over 1,000 mg per day may also increase the risk of kidney stones in predisposed people.

Anti-oxidant – Glutathione

- Glutathione is not classed as a vitamin; it is an antioxidant produced in the cells. It's comprised largely of three amino acids: glutamine, glycine, and cysteine.

- Glutathione levels in the body may be reduced by a number of factors, including poor nutrition, environmental toxins, and stress. Its levels also decline with age.

- In addition to being produced naturally by the body, glutathione can be given intravenously, topically, or as an inhalant. It's also available as an oral supplement in capsule and liquid form. However, oral ingestion of glutathione may not be as effective as intravenous delivery for some conditions.

Glutathione benefits

Reduces oxidative stress

- Oxidative stress occurs when there's an imbalance between the production of free radicals and the body's ability to fight them off. Too-high levels of oxidative stress may be a precursor to multiple diseases. These include diabetes, cancer, and rheumatoid arthritis. Glutathione helps stave off the impact of oxidative stress, which may, in turn, reduce disease.

- An article cited in Journal of Cancer Science and Therapy indicated that glutathione deficiency leads to increased levels of oxidative stress, which might lead to cancer. It also stated that elevated glutathione levels raised antioxidant levels and resistance to oxidative stress in cancer cells.

May improve psoriasis

- A small study indicated that whey protein, when given orally, improved psoriasis with or without additional treatment. Whey protein had been previously demonstrated to

increase glutathione levels. Study participants were given 20 grams as an oral supplement daily for three months. Researchers stated that more study is needed.

Reduces cell damage in alcoholic and non-alcoholic fatty liver disease

- Cell death in the liver may be exacerbated by a deficiency in antioxidants, including glutathione. This can lead to fatty liver disease in both those who misuse alcohol and those who don't. Glutathione has been shown to improve protein, enzyme, and bilirubin levels in the blood of individuals with alcoholic and non-alcoholic chronic fatty liver disease.

- A study reported that glutathione was most effective when given to people with fatty liver disease intravenously, in high doses. Participants in the study also showed reductions in malondialdehyde, a marker of cell damage in the liver.

- Another study found that orally administered glutathione had positive effects on people with non-alcoholic fatty liver disease following proactive lifestyle changes. In this study, glutathione was provided in supplement form in a dose of 300 milligrams per day for four months.

Improves insulin resistance in older individuals

- As people age, they produce less glutathione. Researchers at Baylor School of Medicine used a combination of animal and human studies to explore the role of glutathione in weight management and insulin resistance in older individuals. Study findings indicated that low glutathione levels were associated with less fat burning and higher rates of fat storing in the body.

- Older subjects had cysteine and glycine added to their diets to increase glutathione levels, which spiked within two weeks, improving insulin resistance and fat burning.

Increases mobility for people with peripheral artery disease

- Peripheral artery disease occurs when the peripheral arteries become clogged by plaque. It most commonly happens in the legs. One study reported that glutathione improved circulation, increasing the ability of study participants to walk pain-free for longer distances. Participants receiving glutathione rather than a saline solution placebo were given intravenous infusions two times daily for five days, and then analysed for mobility.

Reduces symptoms of Parkinson's disease

- Parkinson's disease affects the central nervous system and is defined by symptoms such as tremors. It currently has no cure. One older study documented intravenous glutathione's positive effects on symptoms such as tremors and rigidity. While more research is needed, this case report suggests that glutathione may help reduce symptoms, improving quality of life in people with this disease.

May help fight against autoimmune disease

- The chronic inflammation caused by autoimmune diseases can increase oxidative stress. These diseases include rheumatoid arthritis, celiac disease, and lupus. According to one study, glutathione helps reduce oxidative stress by either stimulating or reducing the body's immunological response. Autoimmune diseases attack the mitochondria in specific cells. Glutathione works to protect cell mitochondria by eliminating free radicals.

May reduce the impact of uncontrolled diabetes

- Long-term high blood sugar is associated with reduced amounts of glutathione. This can lead to oxidative stress and tissue damage. A study found that dietary supplementation with cysteine and glycine boosted glutathione levels. It also lowered oxidative stress and damage in people with uncontrolled diabetes, despite high sugar levels. Study participants were placed on 0.81 millimoles per kilogram (mmol/kg) of cysteine and 1.33 mmol/kg glycine daily for two weeks.

May reduce respiratory disease symptoms

- N-acetylcysteine is a medication used to treat conditions such as asthma and cystic fibrosis. As an inhalant, it helps to thin mucus and make it less paste-like. It also reduces inflammation. N-acetylcysteine is by-product of glutathione.

- Glutathione is found in some foods, although cooking and pasteurisation diminish its levels significantly. Its highest concentrations are in:
    - Raw or very rare meat
    - Unpasteurised milk and other unpasteurised dairy products
    - freshly-picked fruits and vegetables, such as avocado, and asparagus.