the why and how behind

byMae

prenatal+

for planning and pregnancy

hydration AM drink
sleep support PM capsules

prepared by: Ferro, M. ; Graubard, C; Edited by: Fields-White, M

a note from the founders

As three moms, we know pregnancy can be a tough road. Each of us have faced our own struggles during and after our pregnancies including prenatal and postpartum depression, hyperemesis, gestational diabetes, preeclampsia, placenta previa, and a high-risk monochorionic-diamniotic pregnancy. We understood that many factors contributed to our circumstances, and we addressed those concerns as best we could—most important of which, maintaining a healthy diet that nourished ourselves and our growing babies.

But it wasn't easy to consume in a day all of the necessary, or right combination of necessary, nutrients. In the end, we realized more could be done, and improved upon, for future parents.

In 2023, we set out to develop the world's first prenatal vitamin that contains all of the recommended nutrients, as endorsed by the American College of Obstetricians and Gynecologists for nutrition during pregnancy, at their suggested dosages. No other available prenatal vitamin on the market can say the same.

Through our amazing partnership with Nutrition Formulators, we identified the perfect formulation process that took into account many factors. That includes the format (drink or capsule), flavors (what works best with the combination of vitamins and minerals), and last but not least, ease of use. Every decision we made, we made with you in mind. There is a reason behind every choice, ranging from the exact ingredients we chose to our design and packaging.

We made this for you,

Vivian Michelle D'nae

byMae

Table of contents

Section 01: introduction .....Page 04

Section 02: byMae prenatal+ hydration drink AM formula .....Page 05

Section 03: byMae prenatal+ sleep support capsules PM formula.....Page 05

Section 04: how we chose our prenatal+ ingredients.....Page 06

Section 05: figure 1.1 byMae prenatal+ exactitude and care.....Page 07

Section 06: timing is everything.....Page 08

figure1.2 mineral antagonism.....Page 09

Section 07: brain development during pregnancy.....Page 10

Section 08: nutrients during pregnancy.....Page 11

the macros.....Page 12-13

the micros.....Page 14-20

figure 1.3 why we use 5-MTHF in our formula.....Page 14

figure 1.4 iron during pregnancy.....Page 15

figure 1.5 daily recommended dietary allowance of vitamins, micro- and macronutrients during pregnancy.....Page 20

Section 09: references.....Page 21

Section 10: about our formulation partner.....Page 22

Section 11: contact us.....Page 22

01 introduction

While pregnancy can be tough, worrying about your growing family's nutritional health shouldn't add to that stress. That's why getting essential nutrients is crucial, especially since your baby relies on your nutrient stores to fuel their development. The right nutrients can significantly impact your child's future health, shaping their risk for diseases like cancer, heart disease, and diabetes.

During pregnancy the body undergoes many physiological shifts, which requires a surge in nutrient intake to fuel the development of the fetus. While a healthy and well-balanced diet is crucial, the effects of nausea and vomiting during pregnancy (NVP) or more serious hyperemesis gravidarum (HG) can make it difficult to meet nutritional needs through food and diet alone. This is where prenatal vitamins become critical—they help bridge nutritional gaps and support a healthy pregnancy.

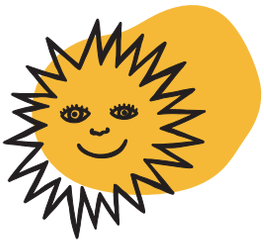
From the onset of a pregnancy, the embryo begins its rapid development, relying on their birthing parent's stores of nutrients to sustain its growth and development [1]. If nutrient levels are inadequate, fetal growth and development can be seriously compromised—especially when it comes to the lack of micronutrients (like zinc and iron), which are needed to meet the high-metabolic demands of early pregnancy [1, 2]. Many researchers claim that pre-pregnancy nutrition is essential before conception [3] and that decisions made during pregnancy can have a significant effect on the child's health, including their lifetime risk of developing cancer, cardiovascular disease, hypertension, diabetes, and other diseases [4].

It was with this in mind that we developed byMae prenatal+. Our formula optimizes the efficaciousness of vitamins and minerals based on when, and how, they will be best absorbed by the body.

Vitamins and minerals can act as agonists or antagonists to one another. This means that they can enhance each other's absorption in the body, and even boost overall effects. At the same time, they can compete for absorption, making it more likely that a user will not get the full benefit of their supplement. For this reason, jamming all of the recommended minerals into the same formula may be undesirable.

When designing the byMae prenatal+ formula, we thought it best to divide the product into two separate parts: AM and PM. This allowed the team to pair micronutrients based on when they would be best absorbed and create ample time between usage to allow for proper digestion. Below, we explain what each ingredient does in the body, why we chose to include it in our AM or PM formula, and how they interact with one another.

02 AM formula



The ingredients in our AM formula were selected because: 1) they are best absorbed in the morning, 2) they are not antagonists to one another (they will not compete for absorption), and 3) they support each other's absorption. Here is the list for our AM formula:

- Calcium: A mineral powerhouse that is best absorbed in the morning
- Choline
- Potassium Iodide
- Vitamin C
- Biotin
- Vitamin K2
- Vitamin B3
- Chromium
- Vitamin E
- Vitamin D3
- Vitamin B5 Calcium Pantothenate
- Vitamin B2 Riboflavin
- Vitamin B1 Thiamine

03 PM formula

Like our AM formula, our PM formula was chosen based on optimal absorption time for each ingredient. The following ingredients listed below will not compete for absorption, and will best support each other's absorption. In this mix, we also offer our Omega-3s in a separate capsule to bolster the efficacy of the PM formula.

- Vitamin A
- Folate Vitamin B9
- Magnesium
- Selenium
- Iron
- Zinc
- Vitamin B12 Natural
- Vitamin B6
- Manganese
- DHA

04 how we chose our ingredients

The American College of Obstetricians and Gynecologists (ACOG) endorses the use of specific nutrients and their recommended dosages during pregnancy. But getting the right amount of each nutrient isn't always easy. A 2019 report from the JAMA Open Network found that many pregnant women were consuming too little or too much of certain key nutrients during pregnancy, and a 2023 Consumer Reports research showed that none of the prenatal vitamins they reviewed met all of the ACOG's recommendations. In fact, a 2022 review of over 20,000 US dietary supplements found that only one product, which wasn't even a prenatal and cost over $200 per month, met the target doses for six key nutrients during pregnancy (vitamin A, vitamin D, folate, calcium, iron, and Omega-3s and fatty acids).

That's where byMae prenatal+ comes in. Our formula contains all of the vitamins and minerals recommended by ACOG at their recommended targets, addresses those nutrients that JAMA found were most likely to be lacking, and includes a few more that help boost the effects of other ingredients. Table 1.1 (next page) details all of the ingredients in the byMae prenatal+ formula and whether they are suggested by ACOG, cited in the JAMA report, or both. Ingredients that include dosages are shown because they align completely with ACOG recommendations (where those recommendations are available) and blank cells mean that byMae included the ingredient in its formula as an added benefit.

05 figure 1.1 byMae prenatal+ formulated with exactitude and care

byMae prenatal+ total	AM/PM	ACOG	JAMA
Calcium	AM	Calcium - 1,000 mg	Calcium
Choline	AM	Choline 450 mg	Choline
Potassium Iodide	AM	Iodine - 220 mcg	Iodine
Vitamin C	AM	Vitamin C - 85 mg	Vitamin C
Biotin (b7)	AM		
Vitamin K2	AM		Vitamin K
Vitamin B3	AM		
Chromium	AM		
Vitamin E	AM		Vitamin E
Vitamin D3 Natural	AM	Vitamin D - 600 IU	Vitamin D
Vitamin B5 Calcium Pantothenate	AM		
Vitamin B2 Riboflavin	AM		
Vitamin B2 Riboflavin	AM		
Vitamin B1 Thiamine	AM		
Vitamin B1 Thiamine	AM		
Vitamin A	PM	Vitamin A - 770 mcg	Vitamin A
Folate Vitamin B9	PM	Folic Acid - 600 mcg	Folate
Magnesium	PM		Magnesium
Selenium	PM		
Iron	PM	Iron - 27 mg	Iron
Zinc	PM		Zinc
Vitamin B12 Natural	PM	Vitamin B12 - 2.6 mcg	
Vitamin B6	PM	Vitamin B6 - 1.9 mg	Vitamin B6
Manganese	PM		
DHA (omegas)	PM	Omega-3s - 550 mg	

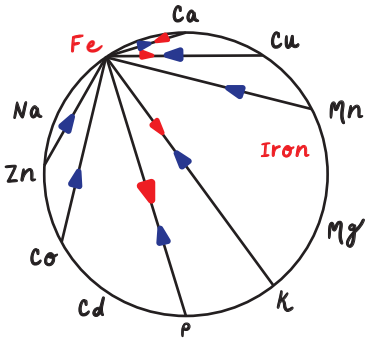
06 timing is everything

Based on our research, timing is everything – that's why we've formulated our prenatal vitamins with the body's natural rhythms in mind. Take magnesium and vitamin B6, for example. These nutrients play a key role in producing melatonin and GABA, a hormone and neurotransmitter that helps you unwind and prepare for sleep. By including them in our PM formula, we ensure they can work their magic when you need them most. On the other hand, calcium absorption at the start of the day can get a boost from vitamin D, which the body produces in response to sunlight. That's why we've included it in our AM formula, along with other nutrients that are best absorbed in the morning.

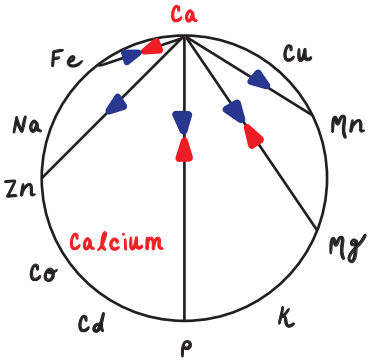
We've also carefully considered the forms of each vitamin and mineral for optimal absorption and effectiveness. For instance, another path to boost the effectiveness of vitamins is by using half of the active coenzyme forms of B complex vitamins, so they can get straight to work in the body tissue without first needing to be converted in the liver. That includes thiamine pyrophosphate (Vitamin B1), riboflavin -5-phosphate (Vitamin B6) and Pyridoxal-5-phosphate (Vitamin B6).

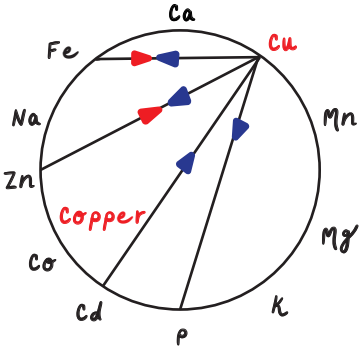
We've even considered how different minerals (agonists versus antagonists) interact with each other, optimizing absorption and metabolization. We know that several minerals can have antagonistic actions between them (see figure below), including calcium and magnesium (as mentioned above), calcium and iron, zinc and copper, and many others. Some minerals compete for absorption, while others work together to enhance their effects. By separating competing minerals between our AM and PM formulas, we ensure that the body can make the most of every nutrient. It's all part of our commitment to providing a prenatal vitamin that truly delivers.

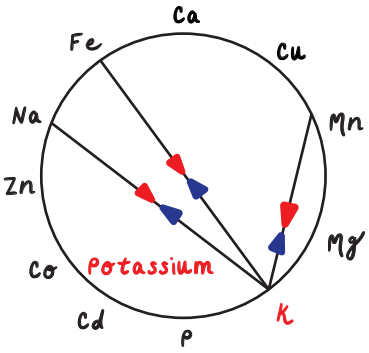
06 figure 1.2 mineral antagonism visualized

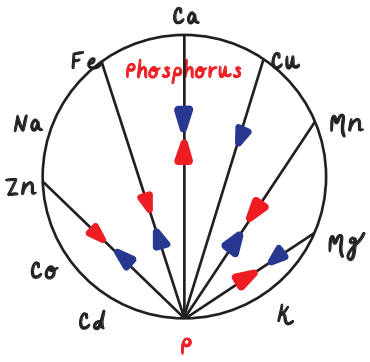


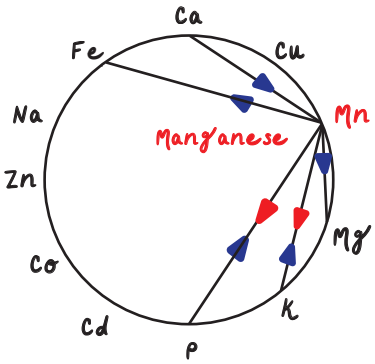
This illustration, created by Dr. Marcelo Ferro, shows how various minerals interact with one another, illustrating the impediments to absorption that exist between them. The arrowheads point to ionic minerals that are suppressed in intestinal absorption by the presence of ionic forms of the mineral at the opposite end of the line. Double, opposite arrowheads on the same line show mutual suppression between elements. Mineral atagonisms cause imbalances of some minerals in relation to others, which cause problems in the utilization of minerals by the body. This interference can be called, “mineral antagonism”. Minerals that do not appear do not influence minerals on the map.

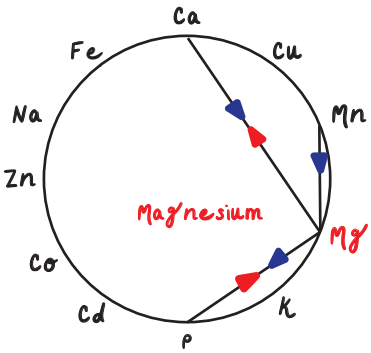


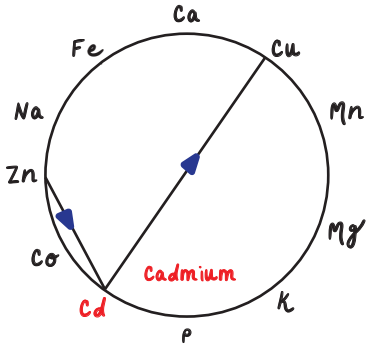


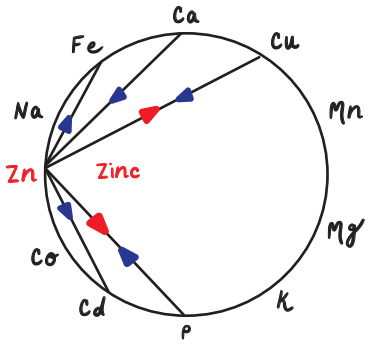


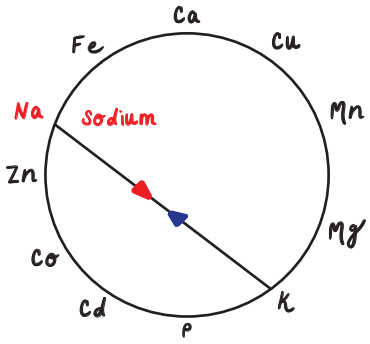












06 timing is everything (cont.)

The chemical shape and structure of the chosen minerals was also based on the body's internal temporal organization, or its natural rhythms. For example, magnesium glycinate can induce sleep and improve protein synthesis during the first three hours of sleep. That's because glycine, when chelated to magnesium, interacts with the brain to control core temperature. Magnesium also plays a key role in sleep metabolism, while glycine acts as an inhibitory neurotransmitter that helps reduce core temperature. Additionally, selenium and manganese aid in detoxification and the removal of free radicals during sleep, as these two minerals serve as cofactors for the enzymes glutathione peroxidase and superoxide dismutase, respectively. Similarly, methyltetrahydrofolate, methylcobalamin, and pyridoxal-5-phosphate vitamins act as methylators that can assist in melatonin synthesis. Using these vitamins at night aligns with metabolic processes.

Conversely, certain vitamins and minerals can enhance enzymes involved in energy metabolism when taken during the day. Cocarboxylase, riboflavin-5-phosphate, niacinamide, and pantothenic acid act on mitochondrial enzymes that synthesize adenosine triphosphate (ATP), the energy currency of human metabolism. Calcium and chromium also contribute to energy and glucose metabolism, respectively, improving overall energy levels in pregnant women. Therefore, separating micronutrients into AM and PM formulas based on biological rhythms and mineral interactions can optimize their benefits.

07 importance of supporting brain development during pregnancy

A baby's brain is an energy powerhouse, and it needs premium fuel to reach its full potential. Brain development places the greatest metabolic demand on newborns—actually consuming more resources and energy for its functioning, growth, and maturation than any other organ [12]. Brain development starts early in pregnancy and shifts into overdrive between weeks 22 and 42 [11]. During this crucial period, the baby's brain undergoes many important changes from the prenatal period and continues through the second year of life. The brain is busy building cells, generating neurons and nerve tissue, and forming neuronal differentiation. In short, the foundation for a lifetime of learning and growth is created [11]. But even minor nutritional gaps can disrupt this complex process, impacting everything from cognitive skills to motor function and social development [13].

Think of this crucial period like building a house: without the right materials and foundation, the structure will be weak and unstable. The same goes for a baby's brain and its development. A baby's brain needs a steady supply of key nutrients to build strong neural pathways and ensure optimal development.

07 importance of supporting brain development during pregnancy (cont.)

As these processes take time, a good diet can help the brain develop and function. It can even affect important brain chemicals such as serotonin, norepinephrine, dopamine, and acetylcholine [14]. Certain fats are also essential for development of the brain's myelin sheaths. For example, docosahexaenoic acid and phosphatidylserine are needed to build brain cell membranes [15]. A lack of these nutrients can cause problems with movement, thinking, and social skills [11]. Even sleep, brain activity, and how the brain reacts to sight and sound can be affected in babies born early who don't get enough nutrients [16].

At byMae, we've carefully selected ingredients that support brain health, including omega-3 fatty acids, choline, and B vitamins, to help nourish your baby's growing mind.

08 the role of nutrients during prenancy

Nutrients are the building blocks of a healthy body, and during pregnancy, they play a starring role in supporting both the pregnant parent and their growing baby. They include carbohydrates, fats, proteins, vitamins, minerals, and water. During pregnancy, more nutrients are needed in order to support a growing baby. According to UNICEF, healthy food choices on a daily basis are crucial to providing a baby with all of the nutritional support they need to develop. If a person doesn't get enough nutrients before or during pregnancy, it can be harmful to them and the baby. These deficiencies can be mitigated with proper interventions, such as micronutrient supplementation [17]. Consuming a healthy diet may be the ideal way to reach nutritional goals, but can be difficult to do in general, and especially during pregnancy. This is why supplements like vitamin D, folate, iron, and calcium are often prescribed during pregnancy. Even with supplements, eating a healthy and varied diet is still important [19].

Still, an estimated 20% to 30% of pregnant people worldwide suffer from some vitamin deficiency [20]. Most studies on nutrition in pregnancy have focused primarily on micronutrients or have examined specific nutrients in isolation, like folic acid or vitamin D [21, 22]. Many studies on macro-and-micronutrients during pregnancy have often overlooked important nutrients like zinc, fiber, or B vitamins (specifically B1, B2, B3) [18]. The scientific community is paying closer attention to this issue and are arguing for more large-scale research on how a lack of nutrients affects pregnancy and how we can improve nutrition for women during pre-conception and during pregnancy [18].

09 macronutrients vs. micronutrients

Nutrients are classified into two categories: macronutrients or micronutrients. Macronutrients provide the body with energy, so we need them in large quantities. The macros consist mostly of proteins, fats, and carbohydrates. Micronutrients are just as essential, even though we need them in smaller amounts. They include vitamins and minerals, which are essential for maintaining wellbeing and overall health. Below is breakdown of each category:

Protein: Key Building Block

Protein is an essential building block for the birthing parents and their baby. It is made up of amino acids, which are key in everything from building cells and tissues to making enzymes and hormones. While proteins are associated with animal products like meat, fish, eggs, and milk, it is recommended that only 18% of the daily intake of protein come from these food sources. We can also find plant-based proteins in legumes, leafy greens, grains, and seeds. However, getting all nine essential amino acids for optimal nutrition can be tricky, especially during pregnancy.

The body swiftly adjusts after conception. The metabolism works overtime several weeks after conception to maintain a healthy balance while accommodating the increased demands of the growing baby and preparing for lactation [23]. While protein turnover in early pregnancy is similar to that of non-pregnant women, protein synthesis ramps up by 15% in the second trimester and a whopping 25% in the third trimester. [24].

This increased production–along with decreased amino acid concentrations, urea synthesis and urinary urea excretion–helps conserve protein and ensure your baby gets the nutrients they need to grow and thrive from early pregnancy and throughout the nine-month period [18]. In healthy and well-nourished individuals, these changes help the body store protein and nitrogen ensuring the baby gets the nutrients it needs [23]. It's almost like the body's own superhero, working behind the scenes to support pregnant mothers and their little ones. Many of the ingredients in byMae's prenatal+ support protein synthesis, including iodine, magnesium, and zinc, whereas manganese and vitamins B2 and B6 aid in protein metabolism.

09 macronutrients vs. micronutrients (cont.)

Carbohydrates: The Body's Fuel

Carbohydrates, those mighty polysaccharides chains of interconnected glucose, are the body's primary source of energy. During pregnancy they fuel the cells, keeping parent and baby powered throughout any given day, and also serve as a key source for the formation of ATP and nucleic acids (DNA and RNA) [25]. But not all carbohydrates are created equal. They affect blood sugar levels differently. Sugary foods like white rice, white bread, fruit juice, and potatoes can cause big spikes in blood sugar, which can be harmful to both the birthing parent and baby [18, 26]. Healthier carbs like fresh fruits, vegetables, rye, oats, yams and sweet potatoes don't cause these spikes in blood sugar [26]. The glycemic load (GL) takes into account both the type and amount of carbohydrates in food and is calculated by multiplying the amount of carbs by a food's glycemic index [27]. It's also important to eat enough fiber, a type of plant carbohydrate that helps with digestion, bowel movements and keeps the blood sugar steady. Good sources of fiber include fruits, vegetables, nuts, and whole grains [28]. Eating healthy carbs and fiber is good for both mom and baby [18].

Fatty Acids: The Unsung Heroes for Pregnancies

Fatty acids, the unsung hero among the macros, are instrumental in pregnancy nutrition and the baby's overall growth and development. These powerhouses come in two main types: essential fatty acids, which the body can't produce on its own and must be obtained through diet, and non-essential fatty acids, which the body can make from other nutrients [29, 30].

Essential fatty acids include linoleic acid (18:2 n-6) and alpha-linoleic acid (18:3 n-3), as well as their long-chain derivatives, arachidonic acid (AA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) [29]. These fatty acids are vital for building tissues and cell membranes, serving as protective barriers within the baby's body. They also play a key role in producing hormones that regulate everything from blood pressure to inflammation. Cold-water fish are rich in these types of fatty acids, especially omega-3 [30].

During pregnancy, levels of fatty acids decrease by around 40%. [30], making the supplementation of these fatty acids, especially long-chain polyunsaturated fatty acids (PUFAs), such as DHA and EPA, essential for the future health of mom and their baby [30]. DHA, for instance, is a major player in brain and eye development. EPA also helps reduce inflammation, thereby potentially lowering the risk of pre-eclampsia [31].

Folate: The Star of B-complex Vitamins

Folate, the star of the B-vitamin family (also known as vitamin B9), is a baby's best friend during those crucial early weeks of pregnancy. Found in leafy greens, citrus fruits, and fortified cereals, folate works tirelessly behind the scenes to support rapid cell division and tissue growth, especially in the developing neural tube (which later forms the baby's brain and spine) [32]. This is all within the first four weeks of pregnancy, when most people may not even know that they are pregnant. That's why getting enough folate supplements early on is so important.

The protective effects of folate supplements wane after pregnancy is established [33]. Higher doses of up to 5 mg per day are generally recommended for high-risk pregnancies. This includes people with a history of diabetes, anti-seizure medication use, and neural tube defects. Intermittent doses of 5 mg per week are also recommended for women with a history of inadequate diets, smoking, and alcohol consumption [34]. Unlike its synthetic cousin, folic acid, folate is naturally found in foods as polyglutamate. To be absorbed and used by the body, it needs to be broken down into a simpler form called monoglutamate [35]. This process happens in the intestines and liver, with the help of a special enzyme glutamate carboxypeptidase II (GPCII) and two transporters known as the proton-coupled folate transporter (PCFT) and and the reduced folate transporter (RFC) [37, 38].

Once the process is completed, much of the folate is converted into its active form, 5-methyltetrahydrofolate (5-MTHF), which is then transported to the liver and placenta [37]. Both natural folate and folic acid are eventually converted into 5-MTHF, but they are absorbed and transported through the body differently. This more bioavailable form of folate, 5-MTHF, is what byMae uses in its formula.

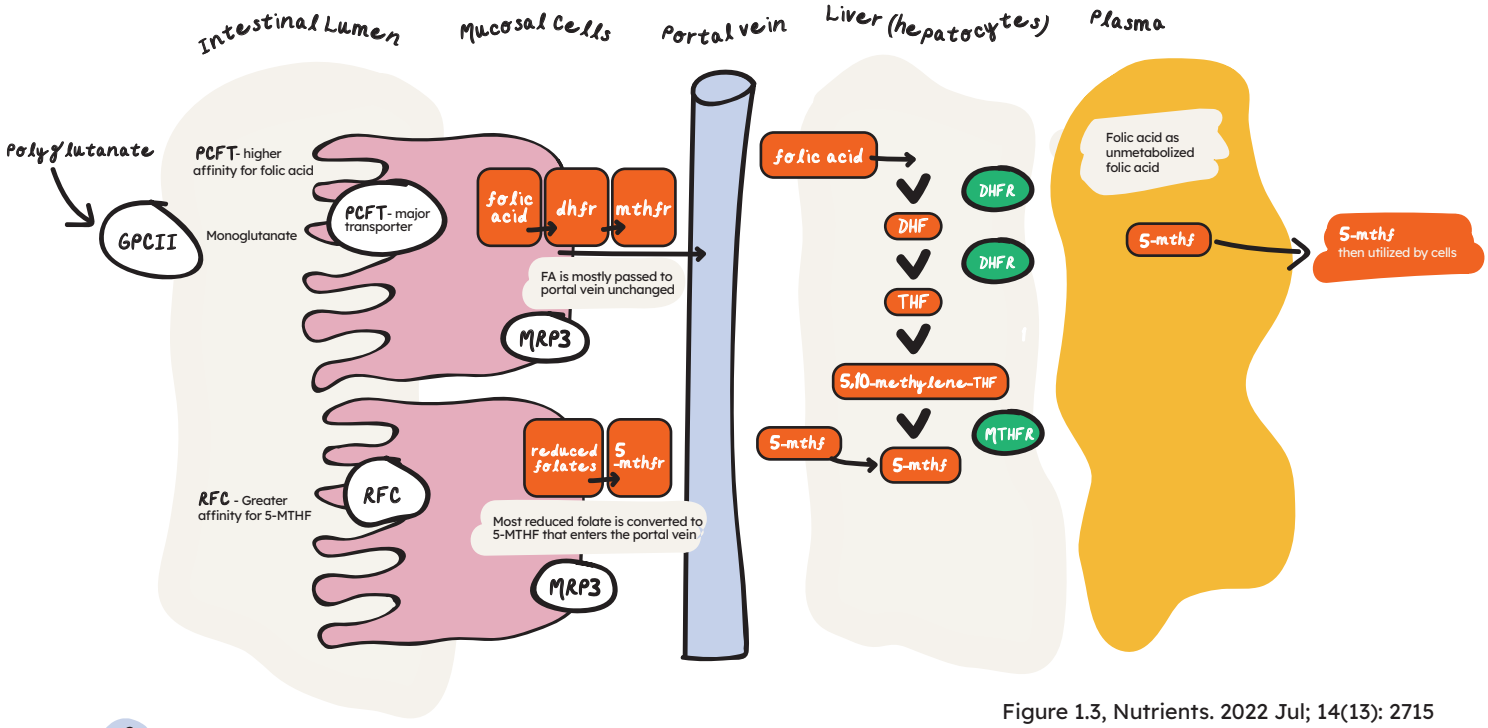


Figure 1.3, Nutrients. 2022 Jul; 14(13): 2715

Vitamin A: Another Unsung Hero

Vitamin A, a fat-soluble vitamin that is stored in the liver, is yet another unsung hero of pregnancy nutrition. While commonly known as Retinol, vitamin A comes in two main forms: preformed vitamin A (found in animal products) and provitamin A carotenoids (found in colorful fruits and veggies like kale and carrots). Both types eventually convert to retinol, the active form of vitamin A [40]. This nutrient powerhouse is essential for vision, growth, bone health, immune function, and gene transcription. It also serves as an antioxidant and supports maternal metabolism. During pregnancy, it's crucial for supporting the growth and maintenance of fetal tissues, as well as for the pregnant parent's overall health [40]. vitamin A [18].

Vitamin A deficiency can cause vision problems, such as night blindness, during preg nancy. This affects about 7.8% of pregnant people worldwide, with 15.3% considered deficient based on scrum retinol concentrations. Some studies suggest that maternal night blindness might be linked to infant death and low birth weight. While a Cochrane meta-analysis of 19 studies with over 310,000 women, found vitamin A supplements didn't affect death rates in mothers or babies, stillbirths, low birth weight, early delivery, or anemia in newborn, it did find that, for people who are already low in vitamin A, taking supplements did help with anemia, infections, and night blindness [40]. Since too much vitamin A can be harmful, pregnant women shouldn't take more than 10,000 IU per day. It's safer to use beta-carotene instead, which is a natural form of vitamin A [18].

B-complex: The Macro Processor

B complex vitamins, a dynamic group of water-soluble nutrients, are necessary for the production and release of energy in cells and for the metabolism of proteins, fats, and carbohydrates. They include B1 (thiamine), B2 (riboflavin), B3 (niacin), B5 (pantothenic acid), B6 (pyridoxine), B7 (biotin), B9 (folate), and B12 (methylcobalamin).
They're found in a variety of foods, from animal products like meat, poultry, fish, and dairy to fortified cereals, legumes, and leafy green vegetables. Think of them as your body's pit crew, keeping your metabolism running smoothly, your energy levels high, and your cells in tip-top shape. These vitamins work as helpers in many ways within the body processes, including making energy, using nitrogen, and forming blood cells [41].

B-vitamins also act as coenzymes in several intermediate metabolic pathways, including energy generation, nitrogen metabolism, methylation processes, and blood cell formation [41]. Vitamin B12 and folate team up to convert homocysteine into methionine, which is an important process for the methylation of DNA, RNA, proteins, and brain chemicals [42]. Vitamins B1, B2, B3, and B5 work on specific enzymes to produce adenosine triphosphate (ATP), the body's energy source [43]. A deficiency of these vitamins can have an impact on cell growth as well as on the development of the baby's nervous tissue due to its high energy demand [18, 44]. Pregnant people need more of these vitamins because they need more energy and protein, especially in the third trimester [18].

B-complex: The Macro Processor (cont.)

Studies show that during pregnancy, the body holds on to more B vitamins to meet the growing baby's needs [29]. But even with these changes, many people are still low on these important vitamins. For instance, one in four pregnant women don't get enough vitamin B12, according to Sukumar et al. [45]. The deficiency of thiamine (vitamin B1) can also affect the baby's brain development [46]. While evidence on the benefits of supplementation of riboflavin and niacin is still sparse, the deficiency of these B vitamins has been linked to problems like preeclampsia, heart defects, and low birth weight. [47,48]. On the bright side, getting more thiamine, niacin, and vitamin B6 around the time of conception seems to help with nausea and might even lower the risk of birth defects like cleft palate [49].

Vitamin D: The Protector

Vitamin D, a multifaceted superstar, plays an instrumental role in everything from bone health to immune function, gene regulation, fighting inflammation, new blood vessels growth, and even glucose metabolism [50]. This fat-soluble vitamin comes in two forms: vitamin D2 (found in some plant-based foods) and vitamin D3 (which your body produces when exposed to sunlight). While both types are important, vitamin D3 is the VIP, as it's more easily absorbed and utilized by the body [51].

After we ingest this vitamin, either through food or the sun, the liver and kidneys change vitamin D into its active form so the body can use it. The vitamin is first hydroxylated in the liver to form 25-hydroxyvitamin D (25(OH)D), the major circulating form and most common measure of vitamin D levels; and then, it is converted in the kidney to form 1, 25-dihydroxyvitamin D (1,25(OH)2D3), the biologically active form [52]. Studies show that the global estimate of pregnant women worldwide who don't get enough vitamin D is about 40% to 98%, and 15% to 84% are severely deficient [60]. Deficiency can be attributed to several factors, including low intake of vitamin D-packed foods, highly-pigmented skin, and lack of sunlight exposure due to sedentary indoor lifestyles [53]. While byMae supports the use of protective measures to prevent skin cancer, such as use of sunscreen and/or UV-ray blocking clothing, they can prevent vitamin D absorption -- making supplementation with Vitamin D3 all the more important.

During pregnancy, babies get all their vitamin D from their birthing parent [51]. In fact, the active form of vitamin D, 1,25(OH)2D3, increases throughout pregnancy, reaching levels that would be toxic in non-pregnant people, according to Hollis et al. [54]. This process is unique to pregnancy and depends on the bioavailability of the 25(OH)D substrate, but is independent of calcium metabolism [54]. Not getting enough vitamin D can lead to pre-eclampsia, gestational diabetes, premature birth, and low birth weight [55, 56, 57, 58]. Also studies show that getting enough vitamin D during pregnancy is crucial in optimizing mom and baby's bone health as well as supporting the baby's growth and development [18].

Calcium: A Mineral Powerhouse

Calcium, a mineral powerhouse, is essential for strong bones and teeth - not just for mom, but also for a growing baby too! This mineral is also a key player in muscle function, nerve transmission, and heart health. And as if that wasn't enough, calcium can even help keep a pregnant person's blood pressure in check, lowering the risk of complications like pre-eclampsia [59].

Calcium needs increase during pregnancy, especially in the third trimester, in order to support the growing baby's bone development. During those final three months, a baby can receive between 250 and 350 milligrams of calcium from their mother each day [60, 61]. The good news is: the body is naturally designed to absorb more calcium during pregnancy, thanks to a boost from hormones like vitamin D, estrogen, and prolactin [60]. And while a pregnant mom can get enough calcium from food alone (1.2 grams a day is recommended), some health experts suggest taking 0.3-2.0 grams of calcium supplements, especially if you don't get enough calcium from your diet (less than one gram a day) [61]. This extra calcium helps keep your bones strong, supports your baby's growth, and might even lower the risk of problems like pre-eclampsia.

A lack of calcium during pregnancy can lead to weaker bones, tingling or prickling sensations (paresthesia), muscle cramps, and even tetanus or tremors. It can also affect baby's growth, potentially causing slower growth, lower birth weight, and problems with bone development [62].

Recent studies show that people who don't get enough calcium are more likely to have high blood pressure or hypertension during pregnancy. The World Health Organization (WHO), which reviewed 21 trials with over 90,000 women from two Cochrane, reported in 2013 that taking calcium lowered the risk of pre-eclampsia by over 50%, no matter how much calcium the women were getting before or their risk of high blood pressure [61, 62]. These findings were most noticeable in women who weren't getting much calcium from their diet (less than 900 mg/day) and women who were already more likely to get pre-eclampsia [63]. Because of these findings, the WHO suggests that pregnant women who are at high risk for preeclampsia or who don't get enough calcium from food take 1.5–2.0 grams of calcium supplements daily [63].

Iodine: A Little Goes a Long Way

Iodine, a trace mineral that's anything but insignificant, is essential for producing thyroid hormones that regulate growth, development, and metabolism. Iodine can be found in many sources like seaweed, seafood, eggs, dairy, and plants grown in iodine-rich soil or areas where animal feed is fortified with iodine [64]. Pregnancy brings about many changes in the body, including making more thyroid hormones, which need iodine to work. The National Health and Medical Research Council (NHMRC) recommends that pregnant women get 220 micrograms of iodine per day [67].

Iodine: A Little Goes a Long Way (cont.)

Early on, the production of thyroid hormones doubles during pregnancy [65], and within a month, iodine passes through the placenta to initiate the growth of thyroid hormones for the baby. This process is critical for the baby's brain and nervous system to develop properly; it helps with nerve cell growth, making connections between those cells, and coating the nerves with a protective layer [66].

Even though the body only needs a little bit of iodine (around 150-290 µg/day) to stay healthy, not getting enough is the top cause of preventable brain and cognitive problems worldwide. It is estimated that 1.8 billion people worldwide are deficient in iodine, with Europe and Southeast Asia reaching the highest proportion, at 44% [64]. Iodine deficiencies for a baby can cause problems ranging from slightly mild to severe intellectual disabilities, the latter of which is irreversible. Studies suggest that iodine deficiency can also lead to other issues like enlarged thyroid (goiters) in both mother and baby, pregnancy loss, and infant death. [64].

Despite little high-quality evidence supporting the use of iodine supplementation during pregnancy, the importance of maintaining adequate maternal iodine levels for fetal development is well established. Therefore, a daily iodine intake of 250 µg is recommended for pregnant and lactating women [67].

Iron: The Mighty Mineral for Mom and Baby

Iron, the mighty mineral among the vital micronutrients, is essential for many processes in your body, like making hemoglobin and myoglobin, transporting oxygen, breathing, growing, regulating genes, and helping enzymes that need iron to work properly [68,69]. During pregnancy, the body's iron needs explode to support expanding blood volume, baby's growing needs, and to compensate for blood loss during delivery [68] (See Fig. 2). The average pregnant person needs around 30 milligrams (mg) of iron per day, which is about twice the amount needed before pregnancy. The CDC recommends starting a low-dose iron supplement at the first appointment with your gynecologist and obstetrician, and continuing to take at least 27 mg per day throughout your pregnancy.

However, iron deficiency remains the leading single nutrient deficiency worldwide, affecting a staggering 38.2% of pregnant women [18]. That can be the result of several factors, like not eating enough iron-rich foods, problems absorbing iron, losing iron due to infections, or bleeding [70]. Plant-based foods like leafy greens and beans have a decent amount of iron, but it's not as easy for our bodies to absorb as the iron found in animal products like meat and fish. This type of iron, called heme iron, is absorbed more efficiently, making it the main source of iron in the diets of meat eaters [68, 69]. If you eat a diet with adequate amounts of meat, seafood, and vitamin C, the body absorbs around 14% to 18% of the iron. Vitamin C is also key for absorbing iron from non-meat sources – about 5% to 12% of the iron you eat [71, 72].

figure 1.4 Iron: The Mighty Mineral for Mom and Baby (cont.)

As mentioned above, the need for iron soars during pregnancy. (See Fig. 2) Studies show that pregnant people need more iron, anywhere from 0.8 to 7.5 mg/day, but exactly how much more in the third trimester is still being debated [73]. As the pregnancy progresses to the final months, more iron is needed [69], making it challenging to get enough iron intake just from a healthy diet, and thus highlights why pregnant people are more likely to develop iron-deficiency anemia [73].

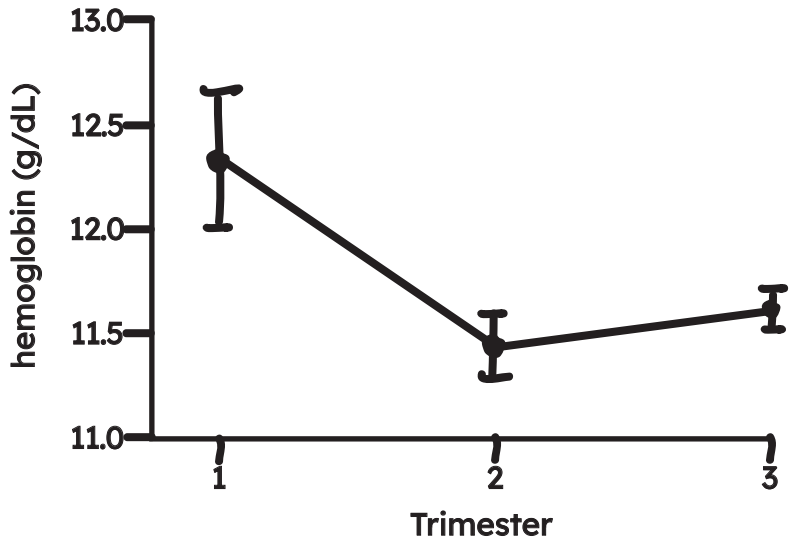


Figure 2: Hemoglobin concentrations of healthy women during pregnancy
J. Obstet. Gynaecol. 2010;30:357-361.

Table 1. Daily Recommended Dietary Allowance for Vitamins, Micronutrients and Macronutrients for Pregnancy.

Vitamins, Micronutrients and Macronutrients	Unit	Institute of Medicine Recommended Dietary Allowance (RDA) for Pregnancy		
		14–18 Years	19–30 Years	31–50 Years
Vitamin A (retinol)	µg	750	770	770
Vitamin B1 (thiamin)	mg	1.4	1.4	1.4
Vitamin B2 (riboflavin)	mg	1.4	1.4	1.4
Vitamin B3 (niacin)	mg	18	18	18
Vitamin B5 (pantothenic acid)	mg	*6*	*6*	*6*
Vitamin B6 (pyridoxine)	mg	1.9	1.9	1.9
Vitamin B7 (biotin)	µg	*30*	*30*	*30*
Vitamin B9 (folate)	µg	600	600	600
Vitamin B12 (cobalamine)	µg	2.6	2.6	2.6
Vitamin C (ascorbate)	mg	80	85	85
Vitamin D (cholecalciferol)	IU	15	15	15
Vitamin E (tocopherol acetate)	mg	15	15	15
Vitamin K (phytomenadione)	µg	*75*	*90*	*90*
Choline	mg	*450*	*450*	*450*
Calcium	mg	1300	1000	1000
Chromium	g	*29*	*30*	*30*
Copper	µg	1000	1000	1000
Fluoride	mg	*3*	*3*	*3*
Iodine	µg	220	220	220
Iron	mg	27	27	27
Magnesium	mg	400	350	360
Phosphorus	mg	1250	700	700
Selenium	µg	60	60	60
Zinc	mg	12	11	11
Potassium	mg	*2600*	*2900*	*2900*
Sodium	mg	*1500*	*1500*	*1500*
Chloride	g	*2.3*	*2.3*	*2.3*
Carbohydrate	g	175	175	175
Fat	g	Not determined	Not determined	Not determined
Linoleic Acid	g	*13*	*13*	*13*
α-Linoleic Acid	g	*1.4*	*1.4*	*1.4*
Protein	g	71	71	71

*Note: Adequate intakes are in *italics*.

Figure 1.5, Nutrients. 2020 Feb; 12(2): 491.

10 references

01. Marshall, N., Abrams, B., Barbour, L., et al.. The importance of nutrition in pregnancy and lactation: lifelong consequences. American Journal of Obstetrics & Gynecology (2021).
02. Stephenson, J., Heslehurst, N., Hall, et al. Before the beginning: nutrition and lifestyle in the preconception period and its importance for future health. Lancet, 391, 1830-1841. (2018).
03. Snyder A, Neufeld HT, and Forbes L. A mixed-methods investigation of women's experiences seeking pregnancy-related online nutrition information. BMC Pregnancy Childbirth. 2020; 20: 377.
04. Jessie Pullar,1 Kremlin Wickramasinghe,1 Alessandro R Demaio. The impact of maternal nutrition on offspring's risk of non-communicable diseases in adulthood: a systematic review. J Glob Health. 2019 Dec; 9(2): 020405.
05. Gernand AD, Schulze KJ, Stewart CP, et al. Micronutrient deficiencies in pregnancy worldwide: health effects and prevention. Nat Rev Endocrinol. 2016 May; 12(5): 274–289.
06. Lopes KS, Ota E, Shakya P, et al. Effects of nutrition interventions during pregnancy on low birth weight: an overview of systematic reviews. BMJ Glob Health. 2017; 2(3): e000389.
07. Patel RM, Kandefer S, Walsh MC. et al. Causes and Timing of Death in Extremely Premature Infants from 2000 through 2011. N Engl J Med 2015; 372:331-340.
08. Santos IS, Matijasevich A, Domingues MR. Late preterm birth is a risk factor for growth faltering in early childhood: a cohort study. BMC Pediatr. 2009; 9: 71.
09. Turpin H, Urben S, Ansermet F, et al. The interplay between prematurity, maternal stress and children's intelligence quotient at age 11: A longitudinal study. Sci Rep. 2019; 9: 450.
10. Pullar J, Wickramasinghe K, Demaio AR, et al. The impact of maternal nutrition on offspring's risk of non-communicable diseases in adulthood: a systematic review. J Glob Health. 2019 Dec; 9(2): 020405.
11. Skinner AM and Narchi H. Preterm nutrition and neurodevelopmental outcomes. World J Methodol. 2021 Nov 20; 11(6): 278–293.
12. Ramel SE, Georgieff MK. Preterm nutrition and the brain. World Rev Nutr Diet. 2014;110:190–200.
13. Dobbing J, Hopewell JW, Lynch A. Vulnerability of developing brain. VII. Permanent deficit of neurons in cerebral and cerebellar cortex following early mild undernutrition. Exp Neurol. 1971;32:439–447.
14. Briguglio M, Dell'Osso B, Panzica G, et al. Dietary Neurotransmitters: A Narrative Review on Current Knowledge. Nutrients. 2018 May; 10(5): 591.
15. Kim H, Akbar M, and Kim Y. Phosphatidylserine-dependent neuroprotective signaling promoted by docosahexaenoic acid. Prostaglandins Leukot Essent Fatty Acids. 2010 Apr-Jun; 82(4-6): 165–172.
16. Herrero MA, Gallego R, Ramos M, et al. Sleep–Wake Cycle and EEG–Based Biomarkers during Late Neonate to Adult Transition. Brain Sci. 2021 Mar; 11(3): 298.
17. Oh C, Keats EC, and Bhutta ZA. Vitamin and Mineral Supplementation During Pregnancy on Maternal, Birth, Child Health and Development Outcomes in Low- and Middle-Income Countries: A Systematic Review and Meta-Analysis. Nutrients. 2020 Feb; 12(2): 491.
18. Mousa A, Naqash A, and Lim S. Macronutrient and Micronutrient Intake during Pregnancy: An Overview of Recent Evidence. Nutrients. 2019 Feb; 11(2): 443.
19. Gernand AD, Schulze KJ, Stewart CP, West KP, Jr., Christian P. Micronutrient deficiencies in pregnancy worldwide: Health effects and prevention. Nat. Rev. Endocrinol. 2016;12:274–289. doi: 10.1038/nrendo.2016.37.
20. Baker H, De Angelis B, Holland B, Gittens-Williams L., Barrett T. Vitamin profile of 563 gravidas during trimesters of pregnancy. J. Am. Coll. Nutr. 2002;21:33–37.
21. Lassi ZS, Salam RA, Haider BA, Bhutta ZA. Folic acid supplementation during pregnancy for maternal health and pregnancy outcomes. Cochrane Database Syst. Rev. 2013.
22. Hollis BW and Wagner CL. New insights into the vitamin D requirements during pregnancy. Bone Res. 2017;5:17030.
23. Elango R., Ball R.O. Protein and amino acid requirements during pregnancy. Adv. Nutr. 2016;7:839S–844S.
24. Duggleby SL and Jackson AA. Protein, amino acid and nitrogen metabolism during pregnancy: how might the mother meet the needs of her fetus?Curr Opin Clin Nutr Metab Care, 5 (2002), pp. 503-509.
25. Alberts B, Johnson A, Lewis J, et al. Molecular Biology of the Cell. 4th edition. Garland Science; 2002.
26. Brouns F, Bjorck I, Frayn KN, et al. Glycaemic index methodology. Nutr. Res. Rev. 2005;18:145–171.
27. Augustin LS, Kendall CW, Jenkins DJ, et al. Glycemic index, glycemic load and glycemic response: An international scientific consensus summit from the international carbohydrate quality consortium (icqc) Nutr. Metab. Cardiovasc. Dis. NMCD. 2015;25:795–815.
28. Qiu C, Coughlin KB, Frederick IO, et al. Dietary fiber intake in early pregnancy and risk of subsequent preeclampsia. Am. J. Hypertens. 2008;21:903–909.
29. Williamson CS. Nutrition in pregnancy. Nutr. Bull. 2006;31:28–59.
30. Al MD, van Houwelingen AC, Kester AD, et al. Maternal essential fatty acid patterns during normal pregnancy and their relationship to the neonatal essential fatty acid status. Br. J. Nutr. 1995;74:55–68.
31. Middleton P, Gomersall JC, Gould JF, et al. Omega-3 fatty acid addition during pregnancy. Cochrane Database Syst. Rev. 2018.
32. De-Regil L.M., Peña-Rosas J.P., Fernández-Gaxiola A.C., Rayco-Solon P. Effects and safety of periconceptional oral folate supplementation for preventing birth defects. Cochrane Database Syst. Rev. 2015.
33. Greenberg JA, Bell SJ, Guan Y, and Yu Y. Folic Acid Supplementation and Pregnancy: More Than Just Neural Tube Defect Prevention. Rev Obstet Gynecol. 2011 Summer; 4(2): 52–59.
34. Bale JR, Stoll BJ, Lucas AO. Institute of Medicine (US) Committee on Improving Birth Outcomes. In: Reducing Birth Defects: Meeting the Challenge in the Developing World. National Academies Press (US) Copyright 2003 by the National Academy of Sciences; Washington, DC, USA: 2003.
35. Scaglione F and Panzavolta G. Folate, folic acid and 5-methyltetrahydrofolate are not the same thing. Xenobiotica. 2014;44:480–488.
36. Obeid R., Holzgreve W., Pietrzik K. Is 5-methyltetrahydrofolate an alternative to folic acid for the prevention of neural tube defects? J. Perinat. Med. 2013;41:469–483.
37. Desai A., Sequeira J.M., Quadros E.V. The metabolic basis for developmental disorders due to defective folate transport. Biochimie. 2016;126:31–42.
38. Shane B., Bailey L. Folate chemistry and metabolism. Folate Health Dis. 1995;2:1–19.
39. Shane B., Bailey L. Folate chemistry and metabolism. Folate Health Dis. 1995;2:1–19.
40. Ledowsky C, Mahimbo A, Scarf V, and Steel A. Women Taking a Folic Acid Supplement in Countries with Mandatory Food Fortification Programs May Be Exceeding the Upper Tolerable Limit of Folic Acid: A Systematic Review. Nutrients. 2022 Jul; 14(13): 2715.
41. McCauley ME, van den Broek N, Dou L, et al. Vitamin A supplementation during pregnancy for maternal and newborn outcomes. Cochrane Database Syst. Rev. 2015.
42. Ang C.D., Alviar M.J.M., Dans A.L., Bautista-Velez G.G.P., Villaruz-Sulit M.V.C., Tan J.J., Co H.U., Bautista M.R.M., Roxas A.A. Vitamin B for treating peripheral neuropathy. Cochrane Database Syst. Rev. 2008.
43. Sukumar N., Rafnsson S.B., Kandala N.-B., Bhopal R., Yajnik C.S., Saravanan P. Prevalence of vitamin B-12 insufficiency during pregnancy and its effect on offspring birth weight: A systematic review and meta-analysis. Am. J. Clin. Nutr. 2016;103:1232–1251.
44. Kennedy DO. B Vitamins and the Brain: Mechanisms, Dose and Efficacy—A Review. Nutrients. 2016 Feb; 8(2): 68.
45. Calderón-Ospina CA and Nava-Mesa MO. B Vitamins in the nervous system: Current knowledge of the biochemical modes of action and synergies of thiamine, pyridoxine, and cobalamin. CNS Neurosci Ther. 2020 Jan; 26(1): 5–13.
46. Sukumar N, Rafnsson SB, Kandala N-B., et al. Prevalence of vitamin B-12 insufficiency during pregnancy and its effect on offspring birth weight: A systematic review and meta-analysis. Am. J. Clin. Nutr. 2016;103:1232–1251.
47. Dias FM, Silva DM, Doyle FC, et al. The connection between maternal thiamine shortcoming and offspring cognitive damage and poverty perpetuation in underprivileged communities across the world. Med. Hypotheses. 2013;80:13–16.
48. Shaw GM, Carmichael SL, Yang W, et al. Periconceptional nutrient intakes and risks of conotruncal heart defects. Birth Defects Res. Part A Clin. Mol. Teratol. 2010;88:144–151.
49. Wacker J, Fruhauf J, Schulz M, et al. Riboflavin deficiency and preeclampsia. Obs. Gynecol. 2000;96:38–44.
50. Gernand A.D., Schulze K.J., Stewart C.P., West K.P., Jr., Christian P. Micronutrient deficiencies in pregnancy worldwide: Health effects and prevention. Nat. Rev. Endocrinol. 2016;12:274–289.
51. Mousa A., Naderpoor N., Teede H.J., De Courten M.P., Scragg R., De Courten B. Vitamin D and cardiometabolic risk factors and diseases. Minerva Endocrinol. 2015;40:213–230.
52. De-Regil L.M., Palacios C., Ansary A., Kulier R., Pena-Rosas J.P. Vitamin D supplementation for women during pregnancy. Cochrane Database Syst. Rev. 2012;2:CD008873.
53. Holick M.F. Vitamin D: Physiology, Molecular Biology, and Clinical Applications. Humana Press; New York, NY, USA: 2010.
54. van Schoor N.M., Lips P. Worldwide vitamin D status. Best Pract. Res. Clin. Endocrinol. Metab. 2011;25:671–680. doi: 10.1016/j.beem.2011.06.007.
55. Hollis B.W., Wagner C.L. New insights into the vitamin D requirements during pregnancy. Bone Res. 2017;5:17030.
56. Aghajafari F., Nagulesapillai T., Ronksley P.E., Tough S.C., O'Beirne M., Rabi D.M. Association between maternal serum 25-hydroxyvitamin D level and pregnancy and neonatal outcomes: Systematic review and meta-analysis of observational studies.
57. Mousa A., Abell S.K., Shorakae S., Harrison C.L., Naderpoor N., Hiam D., Moreno-Asso A., Stepto N.K., Teede H.J., de Courten B. Relationship between vitamin D and gestational diabetes in overweight or obese pregnant women may be mediated by adiponectin. Mol. Nutr. Food Res. 2017;61.
58. Wei S.-Q., Qi H.-P., Luo Z.-C., Fraser W.D. Maternal vitamin D status and adverse pregnancy outcomes: A systematic review and meta-analysis. J. Matern. -Fetal Neonatal Med. 2013;26:889–899.
59. Theodoratou E., Tzoulaki I., Zgaga L., Ioannidis J.P.A. Vitamin D and multiple health outcomes: Umbrella review of systematic reviews and meta-analyses of observational studies and randomised trials. BMJ Br. Med. J. 2014;348:g2035.

together, we create what's next

Nutrition Formulators Inc.

With nearly three decades in the industry, Nutrition Formulators has earned its reputation as a trusted leader in the nutraceutical space. Known for their unwavering commitment to quality and innovation, they've helped bring thousands of products to market, including some of the most recognizable vitamin and supplement brands worldwide. NFI specializes in the formulation, development, and manufacturing of custom products for both humans and animals, offering unmatched vertical integration from initial concept to final delivery. Their team boasts a deep bench of experts—ranging from biochemists to flavoring specialists—ensuring every product is as effective as it is carefully crafted.

Partnering with Nutrition Formulators is teaming up with the best—because when it comes to making something special, you need collaborators who not only know their stuff, but care just as much as you do.

need to get in touch?

hello@bymae.com

byMae inc.
3230 Executive Way
Miramar, FL 33025