Introduction

In the time it takes you to read this sentence, your amazing body will have analyzed, synthesized, restructured, and utilized thousands of nutrient molecules. It will have split proteins, burned sugars, pumped minerals, exchanged gases, and transferred electrons.

Thousands of chemical reactions occur each second in your body, every second of your life. Just imagine the energy required to perform this biochemical magic that powers your human machine!

Where does your body get this energy? The foods you eat provide fuel for your body. The nutrients you consume each day are your body's only source of raw materials. Each chemical reaction occurs in a step-wise sequence and depends on the daily availability of raw materials. A shortage of any nutrient can shut down the "assembly lines" that are your body's biochemical pathways.

Your body is amazingly adaptive and can sometimes function for long periods of time even though particular biochemical "assembly lines" are closed down. Eventually, however, certain nagging symptoms can progress to become diseases that can destroy the quality of life or even life itself.

The proteins, fats, and carbohydrates that you eat are fuel for your physical engine. The vitamins and minerals are its spark plugs. You need both high quality fuel and the ability to "fire on all cylinders" in order to achieve optimal health. An automobile can run with misfiring spark plugs, but for how long and how well? How fast and efficiently can it respond to an emergency demand for more power? The stress of living in our fast-paced world demands that kind of emergency power for our bodies on a daily basis.

Think of other nutrients as protecting agents. Just as your car has additives and devices that protect the body, engine, and driver, nutrients serve to protect your heart, brain, and other critical organs. Just as a car's gauges warn the driver of potential problems, your body has certain chemical indicators that can alert you to potential problems. Early warnings can help you make diet and lifestyle changes that may both extend your life and enhance your quality of life.

Modern laboratory methods let us measure essential vitamins, minerals, amino acids, and fatty acids to see if your body has adequate reserves to meet the demands of your lifestyle and to support your tissue needs for healing. We also look for the presence of specific "marker" chemicals that signal special needs or dangers. For example, methylmalonate is a vitamin B12 marker. If you have a vitamin B12 deficiency, methylmalonate levels rise because the vitamin B12-dependent reaction that converts methylmalonate is inhibited. In this case, you may need vitamin B12 supplements to maintain the health and proper function of your body. In addition to nutrient markers, we also measure markers that assess intestinal health, neurotransmitter activity, and detoxification demands.

No two people are exactly alike. In addition to your unique outward appearance, the way your body functions inside is very much dependent on your individual genetic and environmental influences. You have special needs for dietary nutrients that maintain healthy tissues and fight the processes of disease, degeneration, and accelerated aging. Some people need certain nutrients many times higher than the "normal" dietary intake to allow for the restoration of health. If you don't need them, however, using very high doses of nutrient supplements can cause other imbalances.

The ION™ Profile shows your special needs by measuring nutrients and nutrient marker compounds in your blood and urine. The laboratory tests performed on your specimens include:

- ***Amino acids in blood plasma***
- ***Homocysteine in blood serum***
- ***Mineral (Element) analysis in red blood cells***
- ***Fat-soluble vitamins in blood serum***
- ***Lipid peroxides in blood serum***
- ***Fatty acids in blood plasma***
- ***Organic acids in urine***

The color scheme shown in the list will be used in the text and figures of this booklet.

To help you understand how your recommendations were created, this booklet is organized by nutrient category to show how each component of the ION Profile relates to your nutrient status. Your special needs for vitamins, minerals, amino acids, fatty acids, and antioxidants are determined by grouping together all of the test results that indicate your need for supplementation. The words for results measured in your profile will be in color and match the test listed above. The recommendations are adjusted according to the significance of results. There are many areas of overlap among the data, showing the value of this integrated set of laboratory tests. Your healthcare provider, with full knowledge of your medical history and concerns, can use this information to provide an optimal nutritional support program for you.

The ION™ Profile and Your Nutritional Needs

The paragraphs that follow explain the importance of measured compounds (*shown in color*) to your biochemistry and health. Each compound reveals your areas of internal strengths and weaknesses and your need for specific nutrients.

Vitamins

Vitamins are compounds that your body must have to be healthy. Vitamins are "essential" for proper function, which means they are not made inside your body and must be consumed in the diet. Your body needs vitamins for many reasons. Without them, organs cannot function properly, skin ages rapidly, and vision fails.

Vitamin D

Vitamin D is well known for the role it plays in regulating calcium and phosphorus to maintain bone health. Vitamin D insufficiency has been linked to depression and Seasonal Affective Disorder, neurological autoimmune processes, and in preventing on-going inflammation that damages tissue.

Antioxidant Vitamins

Antioxidant deficiency accelerates the process of aging and the risk of developing chronic diseases. To determine your need for antioxidant vitamins we assess both your levels of specific antioxidant vitamins and markers of oxidative stress. ***Vitamins A***, ***C***, and ***E*** and the nutrients ***beta-carotene*** and ***coenzyme Q10*** are grouped together because they are all involved in antioxidant protection. The principal membrane antioxidant is vitamin E. The ***lipid peroxide*** and ***8-hydroxy-2'-deoxyguanosine*** levels included in the ION profile are indicators of how much damage your body may be sustaining due to lack of antioxidant protection.

Vitamin A

Every day you lose some vitamin A because it is used in the replacement of old tissues. ***Vitamin A*** is an antioxidant in the membranes of your cells where it serves a protective function. Vitamin A is required by the eye for vision and it is also needed to protect the rest of your body from damaging effects of infection and stress. However, too much vitamin A can be dangerous, particularly during pregnancy. If your levels are too high, the recommended intake range will be zero. ***Beta-carotene,*** which also protects tissue, is converted by your body to vitamin A on an as-needed basis. Supplementation with beta-carotene is a safer alternative than vitamin A. ***Lipid peroxides*** indicate damage to cell membranes from oxidation. ***8-hydroxy-2'-deoxyguanosine*** measures the oxidative impact to DNA. The lipid peroxide and 8-hydroxy-2'-deoxyguanosine levels will be high if your total antioxidant protection is inadequate. If these markers are high and vitamin A is normal, then either you need other specific antioxidants (see below) or you have a high rate of free radical oxidant production.

Vitamin C

Vitamin C is easily lost from the body and must be replaced frequently. Many experts agree that the average healthy person needs a minimum of 100-150 mg of vitamin C per day to stay healthy. Diseases and other stresses increase your need for vitamin C. Inadequate vitamin C is one factor leading to elevated ***lipid peroxides***. Elevated ***8-hydroxy-2'-deoxyguanosine*** indicates oxidation and need for vitamin C protection. Extra vitamin C is one way to combat the effects of elevated blood levels of toxic heavy metals like ***mercury***, ***cadmium***, or ***lead***. If the cell regulator that uses vitamin C (***p-hydroxyphenyllactate***) is high, you may need much higher vitamin C intake (up to bowel tolerance doses) to restore normal metabolism and cell control. We measure vitamin C status indirectly with p-hydroxyphenyllactate because vitamin C degrades very rapidly and therefore cannot be measured accurately in a blood specimen sent to the laboratory.

Vitamin E

Vitamin E is a major part of your protection from daily wear and tear. It works to remove harmful molecules that degrade the fatty acids that make up cell membranes (*i.e.*, arachidonic acid). Conditions that increase oxidative metabolism tend to raise your requirements for vitamin E. High levels of ***p-hydroxyphenyllactate***, ***8-hydroxy-2'-deoxyguanosine***, and ***quinolinate*** are associated with increased oxidative stress. Significant elevations in one or more of these compounds could indicate a strong need for other antioxidants as well. The amount of vitamin E that is best for you, again, is influenced by the results of your ***lipid peroxide*** test and your serum vitamin E levels.

Coenzyme Q10

Since your body can make ***coenzyme Q10***, it is not called a vitamin. If you are making enough to meet the demands of your tissues, you do not need to take any extra. However, many people do not make enough coenzyme Q10. Certain drugs have been shown to block coenzyme Q10 production. Elevated ***lipid peroxides*** may indicate a need for coenzyme Q10. High ***hydroxymethylglutarate*** can reveal a block in your body's synthesis of coenzyme Q10. Other functional markers, such as ***lactate***, ***succinate***, ***fumarate***, and ***malate***, indicate whether your body is able to produce energy efficiently by utilizing coenzyme Q10.

B-Complex Vitamins

The B-complex vitamins are necessary for many enzymes in your body to function properly. Your body uses enzymes to extract energy from food, build new tissue, remove toxins, and maintain the immune system.

Vitamin B1, B3, and B5

Vitamins B1 (thiamin), B3 (niacin), and B5 (pantothenic acid) are some of the most easily lost vitamins. All kinds of stressors, both emotional and physical, can increase losses of B vitamins. Vitamins B1, B3, and B5 are necessary for energy pathways of all of the cells in your body. B vitamins are required for proper breakdown and metabolism of the food you eat. Such steps occur in carbohydrate breakdown where ***pyruvate*** and ***lactate*** are formed. Amino acids form ***α-ketoisovalerate***, ***α-ketoisocaproate***, and ***α-keto-ß-methylvalerate***, which require B vitamins for further breakdown. Carbohydrates and amino acids share a common B-vitamin-dependent step where ***α-ketoglutarate*** is formed (Figure 9). If you have a pattern of high levels of these compounds, you may need increased intake of vitamins B1, B3, and B5.

Vitamin B2

Dietary fat, carbohydrate, and protein are all broken down to produce energy using pathways that require vitamin B2 (riboflavin). If you do not have sufficient riboflavin, compounds such as ***succinate***, ***adipate***, ***suberate***, and ***ethylmalonate*** are found high in urine. Some of these compounds also give information about other micronutrients that are discussed below.

Vitamin B6

Your body needs vitamin B6 (pyridoxine) to utilize amino acids derived from dietary protein. Inadequate vitamin B6 is one factor that leads to increased concentrations of ***kynurenate*** and ***xanthurenate*** in urine (Fig. 3). These products of amino acid breakdown cannot be further metabolized in the absence of vitamin B6. Abnormal levels of kynurenate can have direct effects on brain function in addition to showing a need for vitamin B6. ***Glutamine***, ***isoleucine***, and ***leucine*** are other amino acids that serve as marker compounds for vitamin B6. Deficiency of vitamin B6 can result in high levels of these amino acids. Vitamin B6 deficiency may also result in elevated concentrations of ***homocysteine*** in blood, which leads to increased risk of heart disease (Fig. 4).

Vitamin B12 and Folic Acid

The most common dietary deficiency leading to ***homocysteine*** elevation and the associated increase in heart disease risk involves vitamin B12 and folic acid. You can have normal blood levels of these vitamins but still not have enough for your body's enzymes to function properly. Dietary deficiency of vitamin B12 and folic acid are associated with increased risk of many diseases, including anemia and the associated chronic fatigue. ***Methylmalonate*** is a sensitive functional marker for vitamin B12; high levels of methylmalonate indicate vitamin B12 deficiency (Fig. 1). The odd numbered fatty acids containing 15, 17, 19, or 21 carbon atoms **(*heptadecanoic acid*, *nonadecanoic acid*, *tricosanoic acid*, *pentadecanoic acid*)** accumulate in vitamin B12 deficiency. ***Formiminoglutamate*** (abbreviated FIGLU) is a compound made from the amino acid ***histidine*** (Fig. 2). Insufficiency of folic acid leads to high urinary FIGLU. Folic acid is especially critical for prenatal and childhood development. It is important for lowering your risk of cardiovascular disease and cancer.

Biotin

Until recently, biotin deficiency was very difficult to determine in humans because this vitamin deficiency affects health in ways that mimic many other conditions. Doctors were likely to overlook biotin deficiency until this test was discovered. ***Beta(ß)-hydroxyisovalerate*** is a specific and sensitive metabolic marker for functional biotin deficiency. As your biotin intake decreases, your ***ß-hydroxyisovalerate*** excretion increases.

Lipoic Acid

Alpha-lipoic acid (lipoic acid) is classified as a "vitamin-like" compound. It is sulfur containing and is involved in energy metabolism, antioxidant protection, and insulin function. It protects cell membranes by interacting with vitamin C and glutathione. Lipoic acid has been studied as an adjunct therapy for diabetes and liver disease. The urinary markers, ***pyruvate*** and ***lactate***, when elevated can indicate a need for supplemental lipoic acid.

Minerals (Elements)

Minerals make up about 4 to 5 percent of body weight, and not just in the skeleton! We need minerals for nerve transmission, digestion, antibody production, metabolism of nutrients, and more. The term "elemental analysis" is sometimes used because it is the chemical elements like magnesium, iron, and potassium that actually make up mineral compounds. Just about all of the chemical elements that are found in soil or seawater are present in your body. The ones found in very small amounts are called "trace elements".

Measuring mineral concentrations inside your erythrocytes (red blood cells) is one of the best ways to determine their adequacy. Minerals are important catalysts that spark many of the chemical reactions in your body.

Calcium and Magnesium

The most abundant mineral element in your body is ***calcium*****,** because it is the major element in bone. Serum and red blood cell calcium, however, do not represent bone mineral content or dietary adequacy. The most extensively required element is magnesium. Erythrocyte magnesium is a measure of magnesium adequacy. ***Magnesium*** is required for conversion of the metabolic markers ***orotate*** and ***succinate***. Some types of heart problems are aided by using the orotate form of magnesium. Because the supply and regulation of calcium and magnesium are generally linked, it is usually best to use both calcium and magnesium. Your age and sex can help to determine the best amount for supplementation. Normally, because of their role in maintaining and repairing the body, calcium and magnesium must be consumed in hundreds of milligrams per day to maintain a positive balance.

Chromium and Vanadium

The chromium and vanadium content of your erythrocytes can be accurately measured, although their levels are normally very low. The major function of ***chromium*** and ***vanadium*** is to help insulin act on your cells to regulate blood sugar. We also assess the metabolic marker of blood sugar utilization, ***ß-hydroxybutyrate***.

Copper

Copper is part of enzymes, which are proteins that help biochemical reactions occur in every cell. ***Copper*** is involved in the absorption, storage and metabolism of iron. The symptoms of a copper deficiency are similar to iron deficiency anemia. (The liver makes a special protein, ceruloplasm, to transport copper and help convert iron to a form that can be used by other tissues). Copper is utilized by most cells as a component of enzymes involved in energy production, protection of cells from free radical damage, strengthening connective tissue, and brain neurotransmitter function. Excess ***zinc*** intake can result in a copper deficiency when intake of copper is insufficient.

Manganese

Metabolic pathways used for energy production require manganese and iron. ***Manganese*** is a component of several enzymes involved in skin, bone and cartilage formation and blood glucose control. Along with iron and ***copper***, it helps activate an important antioxidant enzyme, superoxide dismutase.

Molybdenum

The trace element molybdenum activates enzymes for building connective tissue and for toxin removal. Molybdenum functions as a cofactor for metabolism of sulfur-containing amino acids. Molybdenum should be balanced with ***chromium*** and ***vanadium***.

Potassium

Erythrocyte potassium levels uniquely reveal your total body potassium status. ***Potassium*** is also an abundant mineral that helps keep normal water balance between the cells and body fluids. Muscle contractions, nerve impulses and blood pressure rely on availability of potassium. Excessive potassium levels in blood interfere with normal heart and nervous function and could be caused by tissue damage. Low red blood cell potassium is rare and can result from poor dietary intake, diarrhea, disease or certain medications.

Selenium

Erythrocytes are heavily loaded with protective selenium enzymes. Measuring erythrocyte selenium content is the best way to check selenium status. ***Selenium*** is required for the production of glutathione, an important antioxidant. High ***pyroglutamate*** or low ***sulfate*** levels in your urine indicate decreased levels of glutathione, which reveals a functional need for selenium. Functioning synergistically with ***vitamin E***, selenium protects against cellular damage from oxygen radicals. Thyroid hormone activation relies on the presence of sufficient selenium.

Zinc

Approximately 100 enzymes that support biochemical reactions in the body rely on zinc. ***Zinc*** is needed for wound healing, a healthy immune system, a healthy sense of taste and smell, and for sexual maturation and development in children. The fatty acid ***LA/DGLA*** (linolenic acid/dihomogammalinolenic acid) and ALA/EPA (alpha linolenic acid/eicosapentaenoic acid) ratio are markers that indicate functional zinc deficiency. Zinc also provides protection against the toxic metal ***cadmium***.

Amino Acids

When dietary protein is digested and absorbed, amino acids flow into the blood stream. Amino acids have many important functions in the body including the regulation of muscle and hormone activity and the formation and maintenance of every tissue in your body *(i.e.*, bone, ligaments, tendons, muscle). Conditions like chronic stress, depression, and toxic chemical exposure increase your need for essential amino acids. Essential amino acids are those that must be provided by the diet because the body cannot make them.

Essential Amino Acids

Supplementing essential amino acids can greatly benefit people who have low protein diets, have trouble adequately digesting protein or who have increased demand for specific amino acids to maintain body processes. Between meals, amino acids supply energy to keep cells functioning. There are certain situations where specific amino acids are recommended to supplement based on particular metabolic needs.

For most people, the safest and most effective way of supporting your diet with amino acids is to take a balanced formula based upon your amino acid profile. The table that follows your vitamin and mineral recommendations describes a formula that can help meet your special needs. This table is based on your levels of essential amino acids in blood plasma. The following essential and conditionally essential amino acids are measured: ***arginine***, ***histidine***, ***isoleucine***, ***leucine***, ***lysine***, ***methionine***, ***phenylalanine***, ***threonine***, ***tryptophan***, and ***valine***. The additional 10 amino acids that are measured can be produced in your body if these amino acids are adequately supplied.

The energy pathways in your cells require the key compounds ***citrate***, ***α-ketoglutarate***, and ***succinate***, which are formed from essential amino acids. Low levels of citrate, α-ketoglutarate, and succinate may indicate amino acid imbalances that can affect your energy pathways (see Figure 9).

5 – Hydroxytryptophan

Tryptophan is an essential amino acid required for the production of the neurotransmitter serotonin. 5-hydroxy-tryptophan (5-HTP) is an intermediate amino acid derivative in this process. Acting as a neurotransmitter, serotonin controls functions relating to mood, behavior, appetite, and sleep. The compound ***5–hydroxyindoleacetate*** (5–HIA) is measured in urine as a marker of serotonin metabolism. When this compound is elevated, it indicates higher than normal turnover of serotonin with potential depletion of tryptophan as a result (Fig. 3). Low levels of 5-HIA may indicate inadequate production of serotonin. 5-HTP can be used as a dietary supplement to increase production of serotonin as therapy for individuals who are depressed, have sleep problems, or chronic pain such as fibromyalgia. Serotonin re-uptake inhibitors (Prozac, Zoloft, etc.) often lead to elevated 5–HIA.

Arginine

Arginine is a conditionally essential amino acid that is critical for your cardiovascular health and detoxification functions The amino acid arginine is used to make the powerful blood vessel regulator nitric oxide. Nitric oxide acts to lower blood pressure. Too little arginine can lead to high blood pressure.

Too much arginine can lead to increased aging from oxidative damage. Arginine is measured in blood and markers of arginine insufficiency are measured in urine. High ***citrate***, ***isocitrate***, ***cis-Aconitate***, or ***orotate*** can indicate arginine insufficiency. The essential amino acid ***lysine*** needs to be present in amounts balanced with arginine to ensure healthy immune system function.

Carnitine

Although not an essential amino acid, carnitine helps your body use fatty acids for energy. The body makes small amounts of carnitine, but if it is not enough, fatty acids are not processed normally, and urinary excretion of the by-products ***adipate*** and ***suberate*** increases (see Figure 9). ***Ethylmalonate***, which comes from a different carnitine-dependent pathway, would also accumulate with carnitine insufficiency.

Glycine

Glycine is an amino acid serving several important purposes within the body, including detoxification, DNA formation, the synthesis of hemoglobin, and as a part of brain neurotransmission pathways. Glycine and serine are interchangeable (Fig. 6). Low plasma levels of glycine and ***serine*** can serve as markers for long term repletion of essential amino acids. In the liver, glycine helps to convert many potentially harmful substances, including toxic materials such as benzoic acid (benzoate) into harmless forms. If urinary ***benzoate*** levels are elevated, it suggests you may benefit from extra glycine. A second detoxification role of glycine is to serve as a necessary part of glutathione, a compound needed by the liver. Urinary ***pyroglutamate*** and ***α-hydroxybutyrat***e levels reflect glutathione demand and availability to the body that improves when extra glycine is provided.

N-Acetylcysteine

Glutathione is constantly used up in the removal of toxic molecules and prevention of oxidative damage. Elevated levels of ***α-hydroxybutyrate*** indicate increased production of glutathione. Elevated levels of the marker ***pyroglutamate*** reveal that glutathione is being lost at a high rate (Fig. 4). Sulfate excretion is another way to check your total body sulfur-containing amino acid status. Low urinary ***sulfate*** is an indication that total body glutathione is low and sulfur-containing amino acids are needed. The amino acid N-acetylcysteine is one agent for effectively raising your glutathione and sulfate levels.

Fatty Acids

Fat is necessary for cell membranes, nerve coverings, hormone production, vitamin absorption, and more. Most of us get a lot of fat in our diet, but it usually is not the quality fat we should be getting. We need to eat more "good" fats from fish, flax seed, olive, vegetable, and nut oils (omega- 3, 6, and 9 fats respectively) and less saturated oils and trans fats (or hydrogenated oils) contained in processed foods. Elevations in ***palmitelaidic*** and/or ***total C:18 trans*** indicate excessive intake of foods containing trans fats. ***Palmitic*** and ***stearic acids*** are significant markers for high consumption of saturated fats. The families of healthy fats called omega-3, omega-6, and omega-9 protect against heart disease and help skin and joints stay young and supple. Hydrogenated and partially hydrogenated oils often contained in shortening, margarine, and many baked goods, as well as excessive dietary saturated fats from animal products, can cause health problems on a cellular level and increase heart disease risk. The fatty acid profile shows the balance of fats and their metabolites in plasma. Your overall balance of omega-3 and omega-6 fats is represented by the ratios of ***AA/EPA*** (arachidonic acid/eicosapentaenoic acid) and ***EPA/DGLA*** (eicosapentaenoic acid/dihomogammalinolenic acid). Overall need for polyunsaturated fatty acids is best represented by ***Mead acid*** and the ***triene/tetraene ratio***. This ratio is calculated by dividing Mead acid by arachidonic acid values. The saturated/unsaturated ratio shows the overall balance of these classes of fatty acids. It can help give a more complete picture of essential fatty acid status. How healthy is the fat you're giving your body?

Fish Oil and Flaxseed Oil (Polyunsaturated Omega-3 Fatty Acids)

This family begins with ***alpha linolenic acid*** (ALA). ALA is an "essential" fatty acid (EFA), meaning that your body cannot make it and you must obtain it from your diet. ALA may be converted into ***eicosapentaenoic acid*** (EPA), a longer fatty acid that is involved in regulation of inflammatory processes and prevention of platelet "stickiness." Diminished platelet stickiness reduces the blood clotting that can lead to heart attack or stroke. Your body can make the other polyunsaturated omega-3 fatty acids from ALA. However, many things can interfere with this process including zinc deficiency, alcohol, obesity, and aging. ***Docosahexaenoic acid*** (DHA) is another omega-3 fatty acid and is integral to brain development in fetuses and infants. The best-known sources of omega-3 fatty acids are cold-water fish, flaxseed, soybean, walnuts and their oils.

Black Currant Seed Oil (Polyunsaturated Omega-6 Fatty Acids)

Linoleic acid (LA) is another "essential" fatty acid (EFA). It is used to make the major membrane polyunsaturated fatty acid ***arachidonic acid*** (AA). High LA relative to other essential fatty acids leads to products that favor inflammatory processes and excessive amounts can lead to cardiovascular disease (Fig. 8). Your body can make other omega-6 fatty acids from LA, like ***gamma linoleic acid*** (GLA), but this process can be blocked by nutrient deficiencies, alcohol abuse, obesity, and aging similarly to omega-3 production pathways mentioned above.

Olive Oil (Monounsaturated Fatty Acids)

Monounsaturated fatty acids are found in foods such as nuts, olives, and their oils. You can get ***oleic acid*** by using olive oil or your body can produce it from saturated fatty acids. Either way, you need this type of fat to build cell membranes that function properly. The other monounsaturated fatty acids measured are usually minor components. They may reveal metabolic imbalances that affect nerve function and cellular energy production.

Environmental Toxin Exposure Markers

One of the most common organic compounds in our environment is xylene. Produced from coal tar or crude oil, xylene is used as a solvent for paints and paint thinners, and its vapors are released from many building and decorating materials such as varnishes and new carpets. Excretion of ***2-methylhippurate*** is a sensitive and specific marker for xylene exposure. Glucarate, on the other hand, serves as a biomarker for your exposure to a wide array of potentially toxic chemicals. High urinary ***glucarate*** suggests above normal exposure to pesticides, herbicides, fungicides, petrochemicals, alcohol, pharmaceutical compounds, or toxins produced in the gastrointestinal tract.

Heavy metals that can be toxic to the body include ***aluminum***, ***arsenic***, ***cadmium***, ***lead***, and ***mercury***. As mentioned earlier, the minerals ***zinc*** and ***selenium*** offer protection against cadmium and mercury respectively. Your healthcare provider may discuss options with you for heavy metal removal if deemed necessary.

Intestinal Microbial Balance Markers

The compounds listed below normally appear in urine only at low levels. With the exception of ***hippurate***, the compounds are not normally produced in the cells of your body. However, unfriendly intestinal microorganisms can manufacture them in relatively high quantities. The compounds are then absorbed into the blood from the intestines and eventually appear in the urine. Microbial overgrowth can lead to a wide variety of symptoms due to reactions to the toxic products produced by bacteria, parasites, or fungi. Various patterns of the compounds reported appear elevated in conditions of general intestinal microbial overgrowth.

Probiotics and Antibiotics

In health, the intestinal tract contains large amounts of beneficial bacteria that produce some B vitamins and provide stimulus for proper immune function. However, if your stomach acid is not adequate, if you fail to digest protein, or if your diet does not supply sufficient fiber, the resulting overgrowth of unfavorable bacteria can release toxic products that your body must remove. These toxic products include: ***benzoate***, ***hippurate***, ***phenylacetate***, ***phenylpropionate*** ***p-hydroxybenzoate***, ***p-hydroxyphenylacetate***, ***indican***, and ***tricarballylate*****.** Your potential to benefit from consuming extra sources of favorable organisms (called probiotics) may go up as the number of toxic compounds and their concentrations increase.

Lactobacillus Acidophilus

D-Lactate elevation is an exception to the use of probiotics just described. *Lactobacillus acidophilus* is widely considered a favorable bacterium to colonize the human gut. It has beneficial effects in many individuals. However, if you have any tendency for carbohydrate malabsorption, even favorable organisms (*i.e.*, *L. acidophilus*) can grow so fast that your blood becomes highly acidic due to the formation of D-lactate. This condition is revealed by high D-lactate in urine.

Saccharomyces Boulardii

It is difficult to know the exact identification of organisms that may be producing the compounds found in your urine. However, one specific compound, ***dihydroxyphenylpropionate*** seems to be strongly associated with a particularly troublesome type of bacteria called Clostridia. This organism is frequently the cause of travelers diarrhea, but its by-products may produce other symptoms. Species of Clostridia are particularly susceptible to displacement by the favorable organism called *Saccharomyces boulardii* that is available in capsules.

Antifungals

Yeast is another class of microbes that can chronically grow in the intestinal tract and cause health effects through the release of toxic metabolites. Because of the multiple, non-specific symptoms they can produce, doctors have searched for ways to know when yeast overgrowth is a problem. ***D-Arabinitol*** is uniquely produced by intestinal yeast, and the degree of elevation is a useful marker of its growth. Favorable organisms and herbal or pharmaceutical antifungal agents suppress intestinal yeast.

Biochemical Pathways

The figures in this section show metabolic pathways involving amino acids, vitamins, and metabolic markers that were measured in the ION profile. They may help explain the significance of your results and demonstrate the importance of nutrients to cell function and health. You can follow the arrows to see how one metabolic compound converts into the next within the delicate and complex network of chemical reactions that are happening in your body. Providing insight into your patient's health is what the ION report is designed to do.

Figure 1. Methylation Cofactor Markers - Vitamin B12

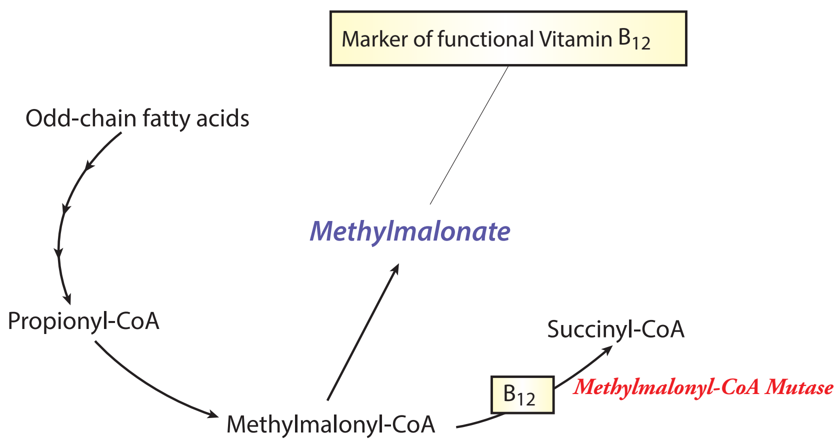


Figure 2. Methylation Cofactor Markers - Folic Acid

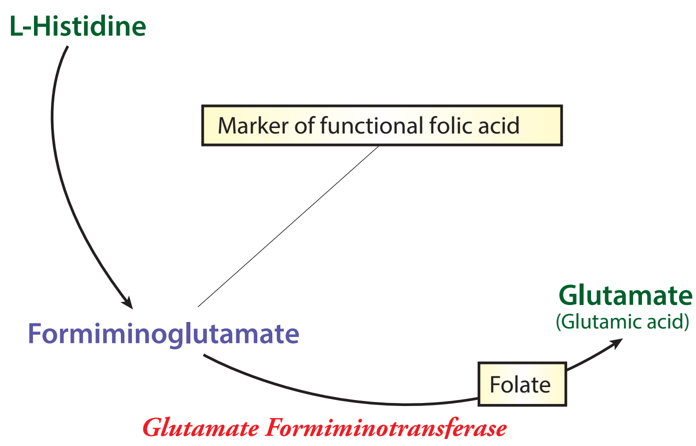


Figure 3. Tryptophan Pathways in Vitamin B6 Deficiency and Inflammation

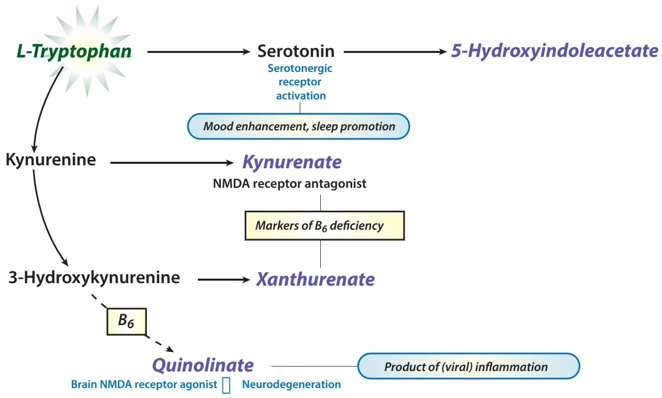


Figure 4. Relationships of Vitamins and Sulfur-containing Amino Acids

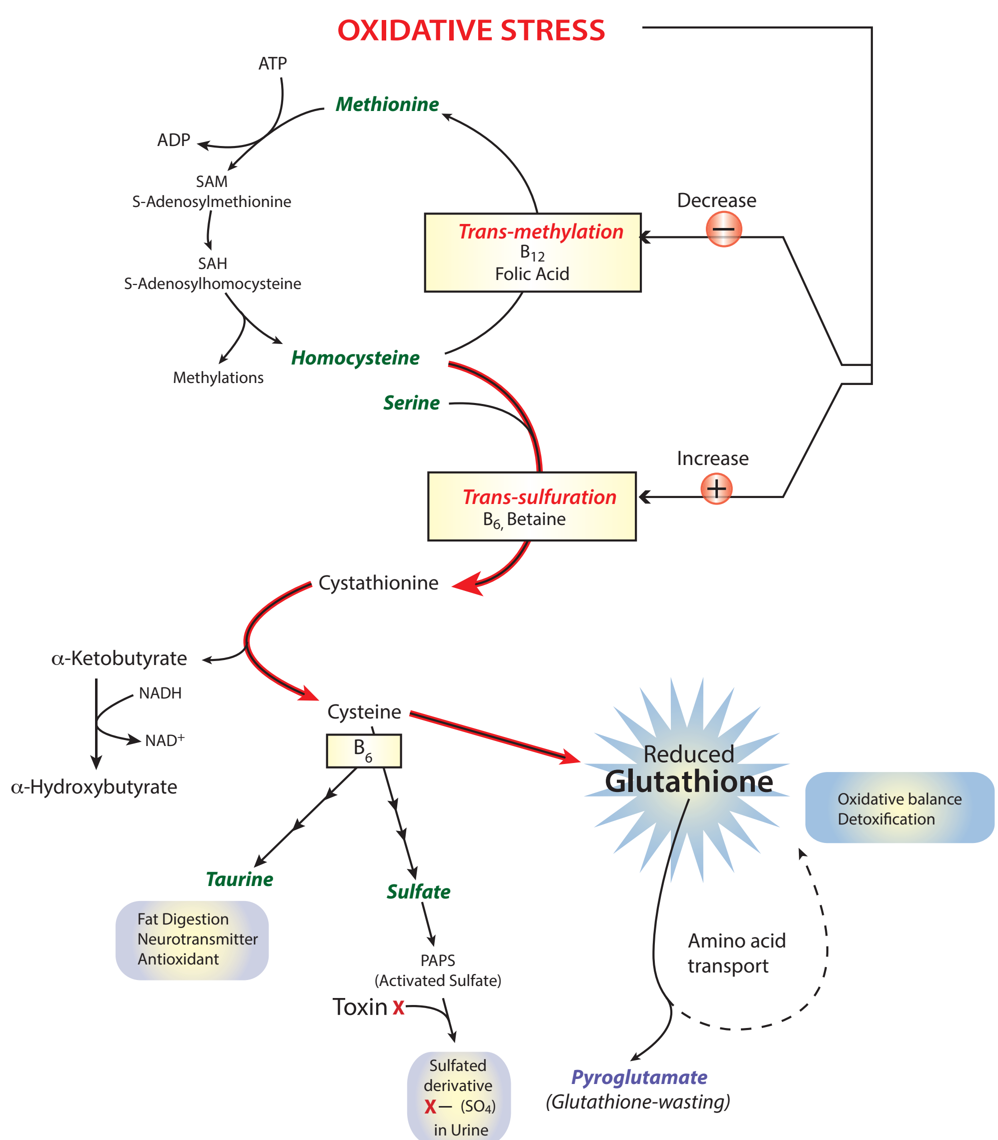


Figure 5. Neurotransmitters from Amino Acids

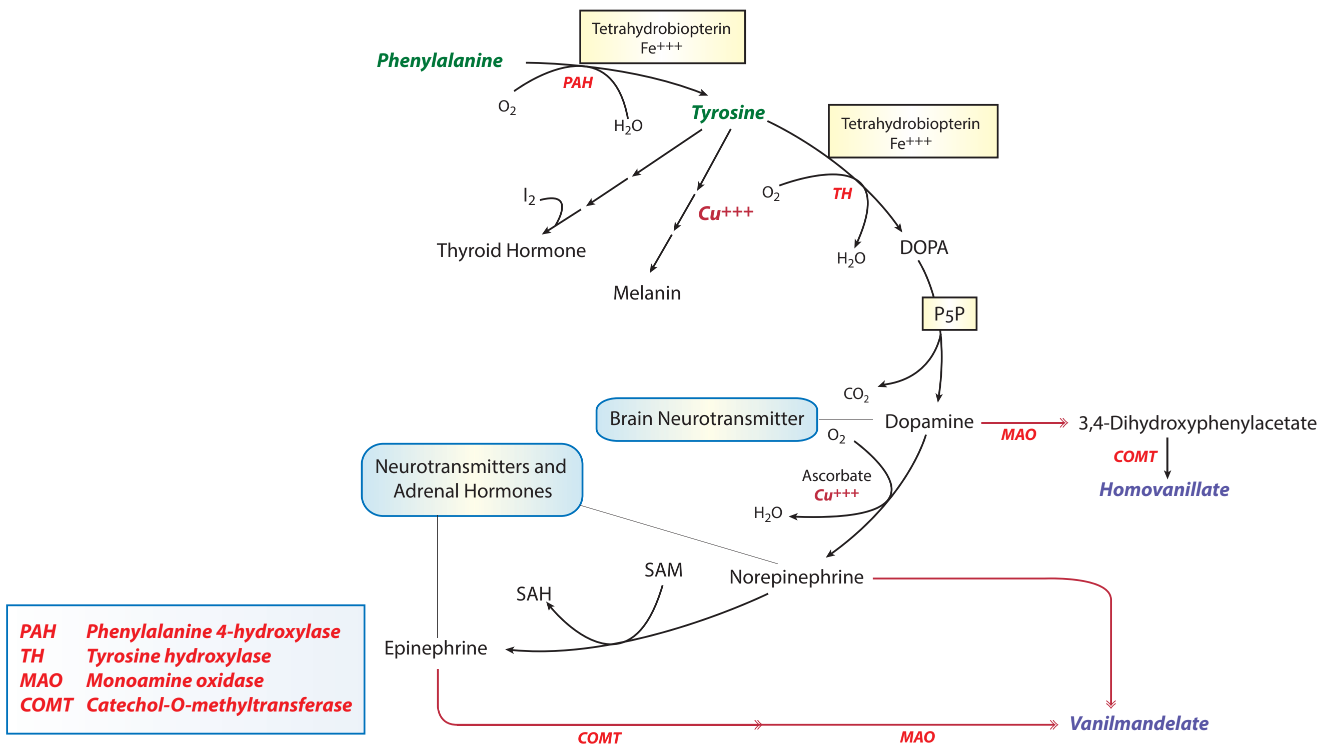


Figure 6. Metabolism of Glycine and Serine

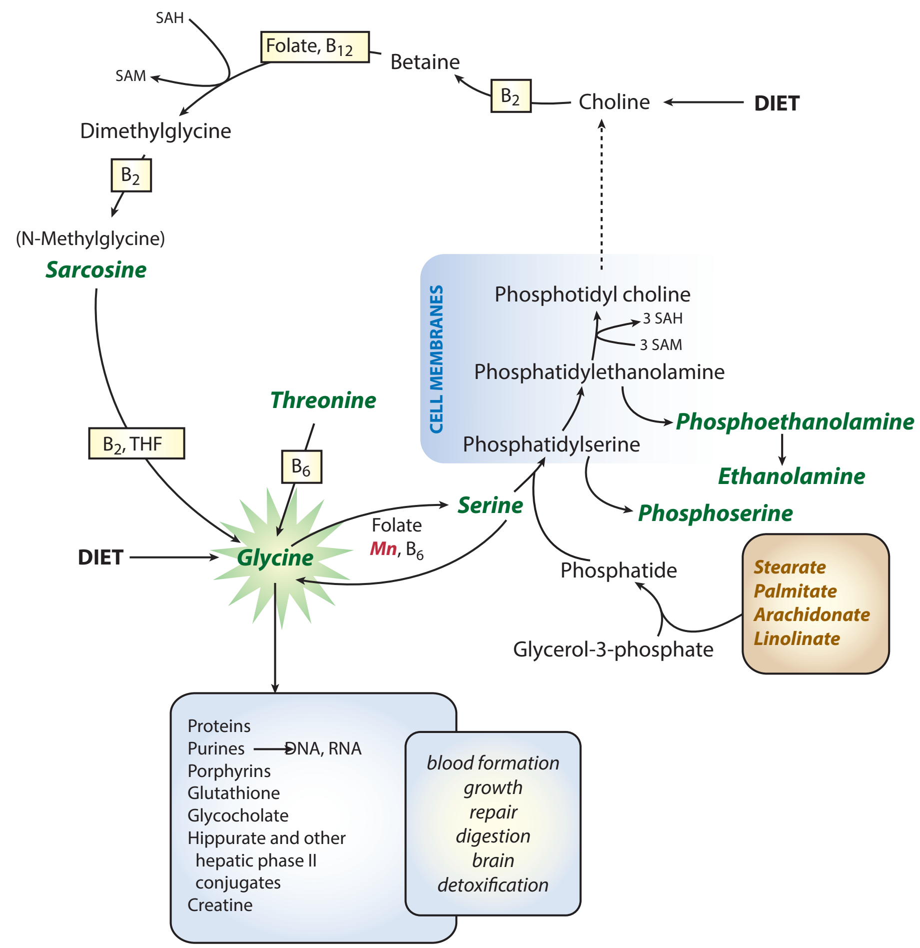
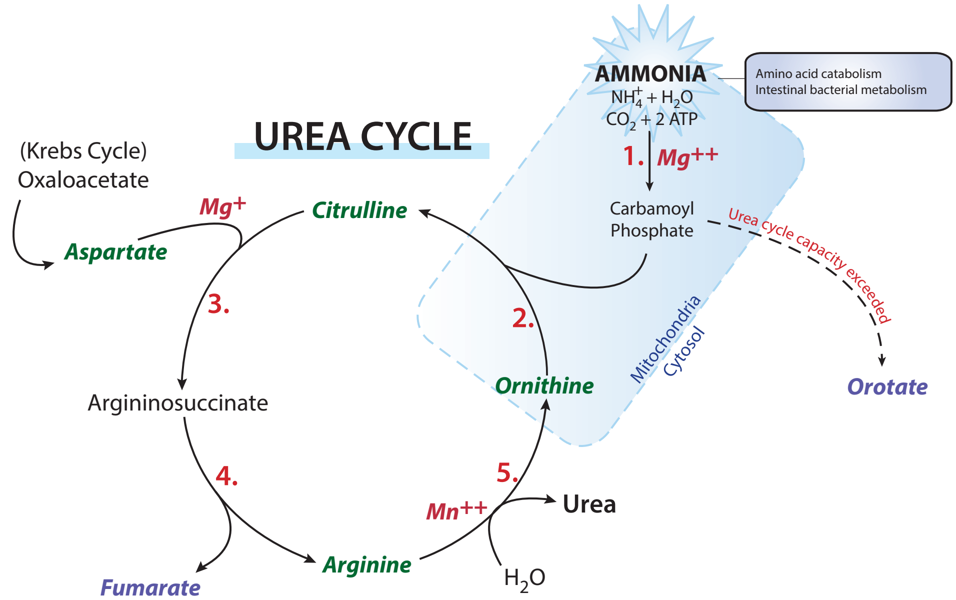
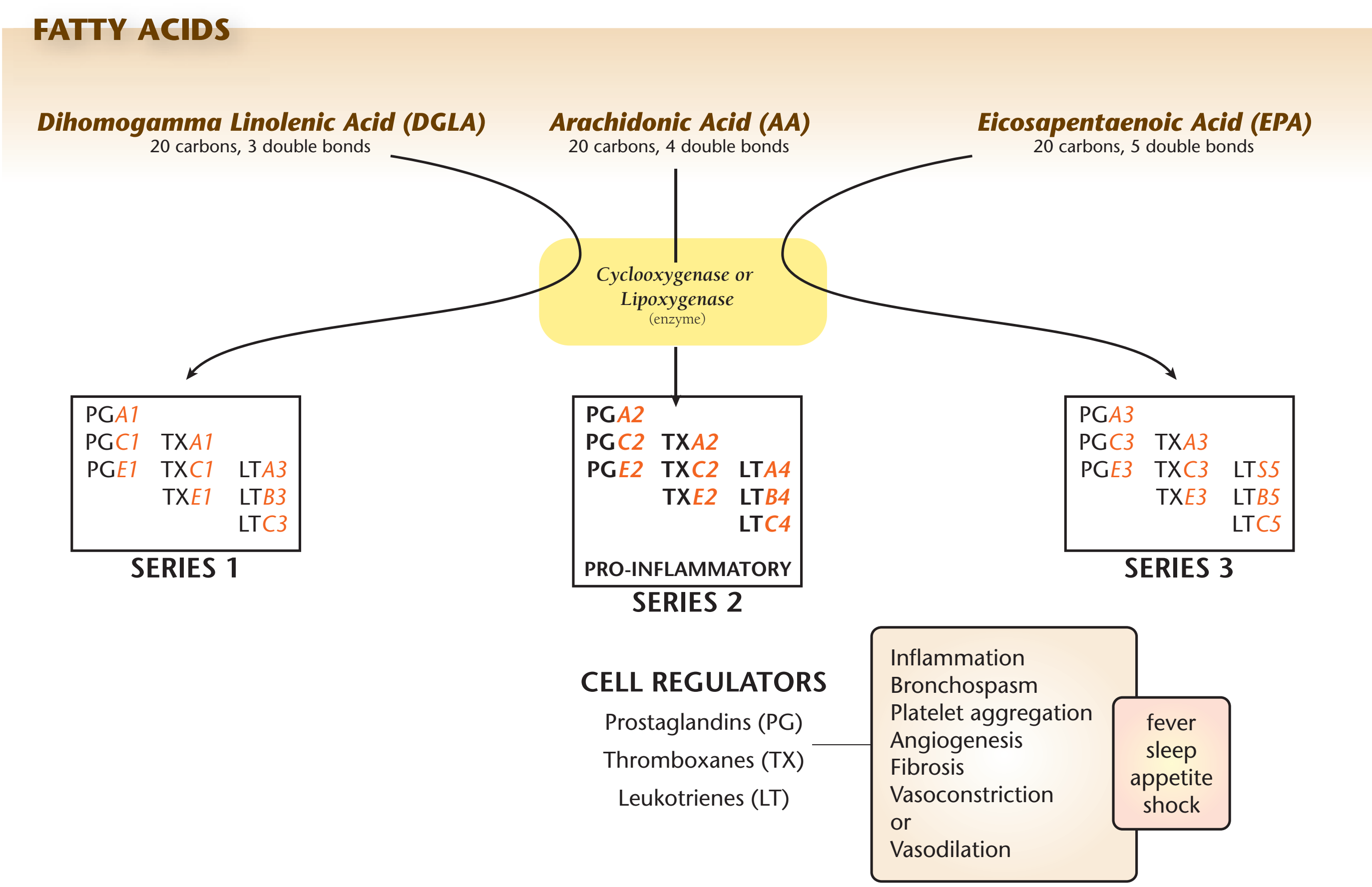


Figure 7. The Urea Cycle for Detoxifying Ammonia



FAULTY ENZYME —— producing ——	HYPERAMMONEMIA AND
1. *Carbamoyl Phosphate Synthase I*	Low Urinary Orotate
2. *Ornithine Transcarbamoylase*	Oroticaciduria
3. *Argininosuccinate Synthase*	Citrullinemia
4. *Argininosuccinate Lyase*	Argininosuccinic Aciduria
5. *Arginase*	Hyperargininemia

Figure 8. Formation of Cell Regulators from Polyunsaturated Fatty Acids



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