Nutrient Crib Sheet
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Background on Nutrients. We have been told for generations that to stay healthy we must eat right -- this means eating a variety of different foods that complement each other and provide all the nutrients we need. However, recent studies and books point out that our diet does not contain enough of some critical nutrients. This is important information, and the stakes are very high -- in our society today there is an epidemic of diseases caused by nutrient deficiencies (see Campbell (2006), Hoffer & Saul (2008), and Pauling (2006) books below). By eating right, we can prevent common causes of heart disease and greatly reduce cancer and viral/bacterial infections. Some writers have criticized "nutritionism" (reductionism in nutrition), saying that eating a "balanced diet" is as good or better than attempting to track the amount of specific nutrients (see Pollan 2007, 2009 books below). Others state that by following a strict vegan diet, without tracking individual nutrients, we can stay healthy (see Campbell (2006) and Esselstyn (2008) books below).

Most of us are deficient in at least several essential nutrients: vitamin C, vitamin D, and magnesium. The traditional meaning of "vitamin" is a chemical required in tiny amounts in the diet. One might imagine, therefore, that we only need small quantities of vitamins C & D, and that they can be readily obtained from an ordinary well-balanced diet. However, our requirement for vitamin C (ascorbate) is not tiny -- we need several grams/day, more when sick. And it is virtually impossible to get enough vitamin D from food. Further, one might also imagine a diet including lots of fruits and vegetables gives us enough magnesium. However, our requirement for magnesium is several hundred mg/day. Most of us don't get that much in our meals. There are several reasons for this. Many of us don't eat enough of the foods such as greens and other colored vegetables that contain adequate amounts of magnesium and other essential nutrients. Magnesium and vitamins are lost when grains are processed by removing the bran and germ, for example, when wheat is made into white flour, or when brown rice is refined into white rice. Fortified foods don't replace many of these essential nutrients. The soils planted by agribusiness are often depleted in minerals such as magnesium after decades of misuse, and modern high-yield cultivars have reduced the amount of minerals in grain (see Dean (2017) book; Thomas, 2007; Fan et al., 2008 below). So in an attempt to stay healthy the body takes magnesium from our bones and we accumulate a deficit. And though our daily requirement for vitamin B-12 is tiny, less than a millionth of an ounce, it is crucial for our health and many of us are deficient.

Individuality of nutrient needs. As individuals we differ in our nutritional requirements because of differences in genetics, biochemistry, and daily life (see Pauling (2006) and Hoffer & Saul (2008) books below). Our ability to absorb and metabolize food to maintain body, organs, and cells differs because of variation in our structural proteins and digestive and metabolic enzymes. Further, our bodies undergo different stresses and we eat different foods. Therefore, our need for essential nutrients differs widely. Although many of us attempt to fulfill some concept of the minimum nutritional requirement, we are commonly malnourished in one way or another. These nutritional deficiencies are the cause of much illness and suffering, but are easy to correct. For many of our nutritional requirements, although we may not know our need precisely, the body can absorb and beneficially use a much higher amount than the minimum. We get enough of most essential nutrients from a well-balanced diet and multivitamin supplements. However, for several nutrients including vitamins C & D and magnesium, to get enough we need to take special care, which usually means taking additional supplements.

Nutrient needs as we age. Young people, growing fast, tend to have robust appetites that will supply a

beneficial amount of nutrients. However, many teenagers and young adults don't eat well, and their diet often lacks essential nutrients such as vitamin C, D, and magnesium. Their bodies can live with this -- for a few years. But as we age, getting enough nutrients from our food becomes a worse problem, for several reasons. We tend to be more sedentary as we age, and thus we simply eat less food. Many of us tend to get overweight as we age, and in trying to reduce our calorie intake, we tend to get less nutrition. Avoiding fat by eating more carbohydrates has recently been shown to encourage weight gain. It is helpful to eat a generous portion of fatty foods, as fat is more satisfying than carbohydrates. Along with adequate doses of vitamins (C,D,E), fat is healthy. Further, many people have difficulty eating foods containing a lot of fiber, and thus tend to eat fewer raw fruits and vegetables. However, aging tissue needs extra nutrients to repair damage done over decades of wear-and-tear. Yet the aging stomach doesn't absorb as much from food. This gives the aging body a much worse problem -- as we get older we tend to eat fewer fresh nutritious foods, and this lack of nutrition compounds the problem because our digestive system then has more difficulty absorbing nutrients. Thus, older people tend to need a higher level of nutrients in their food to stay healthy. Even worse, many age-related diseases (heart disease, strokes, neurological problems, eye problems, arthritis, dementia) are caused by nutrient deficiencies (see Dean 2017 and Hoffer and Saul (2008) books).

Longevity nutrients. Most vitamins and minerals are required for several functions in the body. For example, some vitamins are required for metabolic pathways that produce energy, but they are also required to prevent oxidative damage and maintenance that helps to prevent age-related disease. However, during evolution, the survival mechanisms to keep tissues alive took precedence over maintaining arteries and joints. In the short term, the body can survive without maintenance, but to stay alive it must have energy. So in an evolutionary process of "triage", biochemical maintenance pathways were given lower priority. Natural selection prioritized the cell's nutritional needs and its utilization of essential nutrients to provide energy at the expense of maintenance. This explains why an excess of nutrients helps prevent age-related diseases such as cancer, heart disease and arthritis (see Ames, 2006, 2010a,b, 2014). Millions of years ago, animals evolved to utilize scarce nutrients preferentially for critical body functions such as energy metabolism and blood clotting. The enzymes involved in these critical functions evolved through natural selection to have a high chemical binding affinity for the essential enzyme co-factors known as vitamins. Maintenance enzymes, that required the same vitamin co-factors, evolved lower binding affinities, allowing the vitamin cofactors to be utilized preferentially in times of food scarcity to support the metabolic pathways for energy and other essential functions. Poor nutrition has an insidious damaging effect on health, which directly implicates it as a cause of progressive diseases such as heart disease, high blood pressure, diabetes, and arthritis. The long-term nature of these progressive diseases is related to the damage from long-term deficiencies of essential nutrients such as vitamins C, D, E, K, and the B vitamins, as well as calcium and magnesium and other minerals. Most essential nutrients are relatively safe in much higher doses than in ordinary daily multivitamin tablets. For example, we need high doses of B vitamins to keep the cellular maintenance and disease prevention mechanisms that require these vitamins functioning optimally.

Universality of nutrient benefits. A question often posed about nutritional supplements is, do they really provide big benefits? After all, the food we eat has supported us throughout our lives, so it may seem unlikely that the effects of higher levels of vitamins C & D and magnesium can possibly be so important. The answer is that a deficiency of these nutrients has been documented to have detrimental effects throughout the body on many aspects of our health (see Dean (2017), Hickey & Saul (2008), and Khalsa (2009) books below). But these deficiencies aren't obvious because they have so many symptoms. Therefore, to correct the deficiencies will provide many benefits, giving us better resistance to bacterial and viral infection, better recovery from illness, stress, and injury, freedom from asthma and allergy, and reduced incidence with recovery from arthritis, osteoporosis, cancer, diabetes, heart disease and stroke. The information listed below explains the importance of

these nutrients and how to get enough of them. Doses shown are recommended for adults. Those with smaller or larger body weight may need to vary their dose, and those with special needs should see a nutrition-aware doctor (see Saul (2012) book below).

Vitamin C (L-ascorbate, L-ascorbic acid)

To stay healthy: 3-10 grams/day *(For adults, 15-50 mg/pound/day; for children, half their age in grams/day, in divided doses: 8 years, 4 gms, 1.3 gm/meal.)* Vitamin C is an antioxidant that removes harmful free radicals in the body, and is also essential for the synthesis of collagen, the most common protein in the body. Adequate doses of vitamin C help arteries become stronger and more elastic, and thus help to prevent high blood pressure (Kurl et al. [2002], and Shargorodsky et al. [2010] below). Therefore vitamin C can prevent hemorrhagic stroke and reverse atherosclerosis (see Hickey & Saul [2008] and Levy [2006] and [2012] books), and can also prevent allergy and asthma, and some of the symptoms of diabetes (see Saul [2012] book below). It is essential for most of the body's biochemical and protective processes, to hold the body together in growth and healing, and to strengthen the immune system. Vitamin C is only necessary for higher primates, guinea pigs, and a few other animals, because all other species can make their own. Monkeys, apes and humans lost the ability to synthesize vitamin C through a genetic mutation because an evolving ancestor got sufficient vitamin C by eating large quantities of leaves and fruit (see Pauling (2006) book below). Note that those with glucose-6-phosphate dehydrogenase deficiency (a rare genetic condition) should not take vitamin C in large doses.

However, vitamin C deficiency is common in humans eating processed foods. Many of us get only a minimal amount of vitamin C in our diet, 50-100 mg/day, or if we eat lots of fresh vegetables and fruits, possibly 500 mg/day. However our need for vitamin C is much greater, similar to most other animals that make it in their own bodies -- they make 10-20 grams (relative to our body weight)/day, more under stress. Vitamin C is water soluble and easily distributed throughout the body by the blood, from which it is actively transported into tissues to help build collagen and prevent oxidation, after which it can be recycled by regeneration from other antioxidants, and then eventually eliminated. Therefore for the most benefit we need to take divided doses throughout the day. High levels of blood sugar (e.g. after a meal or in diabetes) reduce vitamin C transported into the body tissues, and therefore vitamin C is most effective when taken without food containing much sugar. Take 1,000-3,000 mg 1/2 hour before each meal. Capsules containing 500 or 1000 mg (1 gm) of vitamin C powder are convenient, but bulk vitamin C powder is less expensive and can be more readily absorbed when dissolved in water or juice. Hard tablets of vitamin C are less well absorbed. Avoid "chewable" vitamin C tablets that contain sugar, because when chewed, the sugar and ascorbic acid may stick to the surfaces of your teeth and etch them. A good alternative for children is chewable tablets containing buffered ascorbate without acidity.

At a dose too high, vitamin C is a mild laxative, and can cause bloating and gas, so if you notice this, reduce intake by 20-50% and take smaller doses spread throughout the day. Some people tolerate buffered ascorbate (sodium, calcium, or magnesium ascorbate) better for it is non-acid. Some people may prefer taking timed-release vitamin C before you go to bed at night. An excellent alternative (but more expensive) source of vitamin C is liposomal vitamin C which is available online and is more completely absorbed so it can provide higher levels of vitamin C for the body than vitamin C in capsule or powder form.

When sick with cold/flu, 3-15 grams/hr *(15-100 mg/pound/hr)* Vitamin C at a sufficiently high dose can prevent viral infections and neutralize bacterial toxins that spread with an acute deficiency (see Levy (2002) and Hickey & Saul (2008) books below). At first sign of symptoms (fever, headache, scratchy throat), many nutritionists recommend 1-3 gms every 20 minutes with water until symptoms are relieved. The body absorbs more vitamin C when under stress, so when you're sick you can take more than normal. Continue taking vitamin

C at a high dose until the symptoms of the cold/flu are gone. If you're already sick, take as much as you can tolerate to prevent an acute deficiency for faster recovery. For most illness or any other type of physical and mental stress, vitamin C helps the body to recover. Vitamin C is relatively safe because it is non-toxic and non-immunogenic. For severe illness, vitamin C can be taken intravenously under a doctor's care as sodium ascorbate (buffered). Existing infections and exposure to environmental toxins like smoke tend to reduce the level of vitamin C in the blood, so take more vitamin C to compensate. See Hickey & Saul (2008), and Levy (2002) books below.

Vitamin D (D3: cholecalciferol)

To stay healthy: 5000-10,000 IU/day *(30-60 IU/pound/day adult dose)***.** Vitamin D is important for the entire body. It is produced by skin exposure to direct sunlight, and can also be acquired by eating oily fish. Vitamin D is required for calcium utilization, immune function, reducing inflammation, and prevention of disease in many body functions. Vitamin D is a powerful hormone -- it interacts with receptors on many cell types throughout the body. If given in sufficient dose it can prevent or reduce the occurrence of many types of cancer, autoimmune diseases, diabetes, asthma, flu, and osteomalacia and osteoporosis. Multiple sclerosis is thought to originate from a deficiency of vitamin D (see Khalsa (2009), Madrid (2009), and Holick (2010) books below), as is the evolution of light skin in populations living at high latitudes (see Jablonski (2008) book below). A widely cited report recommends 600 IU per day for most adults (ODS, 2020), based on bone health. But this excludes vitamin D's known beneficial effects in promoting health and preventing diseases such as cancer and heart disease. Therefore, many nutritionists believe that the dose for most adults should be at least 2,000 IU/day, preferably higher at 5,000 IU/day (Holick, 2010; Heaney & Holick, 2011). A level of 40-60 ng/mL of vitamin D_3 can reduce infections, complications, hospitalizations, and deaths by ~50%, outperforming all patented, FDA-approved COVID-19 therapies (Wimalawansa, 2025). Vitamin D is not toxic at a 5-fold normal dose. Deficiency is very common, especially with office workers who don't get much sun. Because vitamin D protects against skin cancer, some dermatologists advise waiting for 20 minutes of sun exposure before putting on sun block. However any sun exposure increases the likelihood of skin cancer, so taking supplements is recommended instead. Vitamin D is fat-soluble, so the body can store enough for several weeks if given a large dose. Those with a higher fraction of body fat need more vitamin D to give an adequate blood level. A standard blood test for vitamin D levels is widely available and advisable.

Daily dose: Summer. For people throughout most of the lower 48 states with light skin, a 20 minute daily exposure to direct midday summer sun (11-3 PM), on the face, lower arms and legs is sufficient to provide 10,000 IU. For people with dark skin, a daily exposure of the face, lower arms and legs up to 2 hours in the summer midday sun may be required. To minimize the risk from sunburn, the best advice is to expose a greater area of skin for a shorter time, for example, for light skin, expose your back, arms, and legs to sunlight for 2-4 minutes, or for dark skin, for 10-20 minutes. If daily sun exposure is not possible, more exposure to the sun every few days is adequate, for example, during weekends, because vitamin D is readily stored in the body for several weeks. Direct sun exposure is essential because the UVB that creates vitamin D is not transmitted through clouds, glass windows or sunblock. Exposure to the sun cannot cause an overdose of vitamin D, because as the blood level rises the skin automatically self-regulates the amount it produces.

Daily dose: Winter. We get very little vitamin D from the sun when it is less than 45 degrees above the horizon (in North America, April-September: sunrise-10 AM, 4 PM-sunset; October - March: all day). Even when we are outdoors in the winter for a long time and get a little tan, we get almost no vitamin D, for tanning is caused by a different spectrum (UVA) than vitamin D (UVB), which is hardly present when the sun is low in the sky. Therefore, in the winter, supplements are necessary (see Khalsa, 2009 and Madrid, 2009 books below). Both

forms of vitamin D, ergocalciferol (D2) and cholecalciferol (D3), are thought to be equally effective. Oily fish (herring, catfish, salmon, mackerel, sardines, tuna) contain some vitamin D, but not enough for our daily requirements. Although vitamin D is supplied by cod liver oil, it is not recommended as a source of vitamin D, because to get enough one would receive toxic levels of vitamin A. Some dairy products are fortified with vitamin D, but most of these don't provide enough. Milk typically provides 100 IU/cup, requiring 5 quarts to provide the necessary 2000 IU daily dose. A person of 200 lbs may need 7000-10,000 IU/day in supplements when sun exposure is inadequate. To notice the full benefit of vitamin D supplements in a blood test usually takes 6 months to a year, so the test should be done after a few months of supplementation, and at regular intervals thereafter.

Vitamin E (d-alpha, beta, delta, gamma tocopherols and tocotrienols)

To stay healthy, 200-800 IU/day. *(2-4 IU/lb/day).* Vitamin E is a powerful fat-soluble anti-oxidant that helps the body prevent damage to cell membranes and fats caused by oxidation from inflammation and environmental toxins such as smoke. It is carried in the bloodstream by lipoproteins (e.g. LDL) and in turn helps to prevent them and and other fatty acids from being oxidized, and also reduces the need of heart muscle for oxygen. Vitamin E enhances immune function and is known to be helpful in preventing cardiovascular disease and eye diseases such as glaucoma and macular degeneration. It is thought to be helpful in preventing cancer, diabetes, arthritis and asthma. Because vitamin E is fat soluble, its absorption requires an adequate amount of bile, which contains surfactants and fatty acids and is released to help absorb the fat content of food. Thus, low-fat diets tend to lower vitamin E uptake. Vitamin E tends to dilate blood vessels and inhibit platelet aggregation (clotting). Thus it lowers the risk of ischemic stroke, helping the body to gradually break down blood clots and to prevent them forming. Therefore, when taking vitamin E, to lessen the risk of bleeding and hemorrhagic stroke it is important to take a sufficient level of vitamin C (see "Vitamin C" above, and Levy [2006] book). Vitamin E is degraded into an inactive form after it performs its function of removing free radicals, but it can be recycled by the body in the presence of vitamin C. Therefore vitamins C and E taken together are synergistic, and help to prevent high blood pressure, strokes, and heart attacks (see Kurl et al. [2002], and Shargorodsky et al. [2010] below).

Vitamin E comprises 8 different compounds, 4 tocopherols and 4 tocotrienols, but the alpha-tocopherol form is often used synonymously with vitamin E because it is preferentially absorbed and thought to be required in greater amounts by the body. A widely available form, "natural d-alpha tocopherol" is good to take because it is twice as effective as the synthetic form "dl-alpha-tocopherol". However, all of the natural (d-) tocopherols and tocotrienols are thought to be helpful because they serve slightly different functions in the body. Therefore, gelcaps containing “mixed tocopherols” and/or tocotrienols are preferable to those containing only d-alpha tocopherol. Tocotrienols are thought to be a more powerful antioxidant and they are typically 5 times more expensive. Up to 40% of us have low blood levels of vitamin E, and 90% of us don't get even the minimum 15 IU/day. Good sources are wheat germ, vegetable oils such as palm oil, and nuts such as almonds and peanuts. Although a well-balanced diet can provide the minimum 15 IU, it's difficult to get enough vitamin E from the diet to provide all of its benefits, so supplements are helpful.

Vitamin E is effective in helping the skin heal from burns (e.g. after applying cold as first aid, later apply vitamin E), and can be applied directly from a gel-cap. In some supplements, vitamin E is sold in an esterified form, as tocopheryl acetate (or succinate), to prevent oxidation and prolong the shelf life. Normal digestion removes the acetate, so for oral supplements the acetate form is just as effective. However for topical (external skin) application, the acetate form is ineffective, so one must apply the standard d-alpha- or mixed tocopherol form. Doses of 100-200 IU/day are recommended by nutritionists for people over 50 to provide health benefits,

and doses of 400 IU/day up to 800 IU or higher are taken to combat stress and help prevent heart disease. Although vitamin E is very safe at these levels for most people, it is advisable to start taking vitamin E gradually along with vitamin C, and to check with a nutrition-aware doctor if you are taking any blood-thinning drugs (you may need less of them). See Papas (1999) book and web references below.

Magnesium

To stay healthy: a total of 300-600 mg/day. *(2.5-4.5 mg/pound/day for adults, more for teenagers' growth)*. Magnesium is an important nutrient for healthy arteries, muscles, brain and bones, and is involved in hundreds of enzyme reactions. In fact, magnesium is essential for all organs, and its deficiency has many symptoms -- high blood pressure and cholesterol, fatigue, irritability, insomnia, muscle cramps, and eye twitching are common ones. It is important in the prevention of osteoporosis and to balance and regulate the level of calcium, and helps vitamin D to be absorbed and to function in the body. It binds to toxic heavy metals and helps the body to eliminate them. Most of us don't get enough magnesium in our typical daily diet, and stress in our modern lifestyle can cause the body to lose its magnesium, in turn causing more anxiety. Diabetics lose more magnesium than most people, and magnesium is required for the production and function of insulin, so the diabetic magnesium requirement is higher. It also helps to prevent and reverse arthritis. Magnesium helps to prevent asthma because it is a bronchodilator and antihistamine. Many people with asthma are low in magnesium, and drugs for asthma cause the body to lose magnesium. The body closely regulates the magnesium level in the blood, even with a deficiency in the diet, so to keep the level relatively constant the body must remove magnesium from the bones which accumulates a deficit. Therefore a blood test for magnesium usually does not indicate the deficit. Further, as we age, our absorption of magnesium tends to lessen, so our need is greater. Many of us get only 200-300 mg/day, not enough for our body's needs, so we have a deficit. See Dean (2017) book below.

To recover from deficit, take 200-600 mg/day, in divided doses. It may be necessary to supplement with a lot of magnesium at first for several weeks to relieve the deficit, then take a lower level (100-200 mg/day) to maintain a sufficient body level. However before taking magnesium supplements make sure your kidney function is OK. See Dean (2017) book below.

Sources of magnesium: seeds (sunflower, pumpkin), nuts, legumes, tomatoes, chocolate, dark green leafy vegetables, whole grains, wheat germ. A craving for chocolate and nuts may be related to their high level of magnesium. Note that any processed flour including enriched flour has lost almost all of its magnesium -- so white or "wheat" bread, cake, cookies, and most pastas have virtually none. Because most of us don't get enough magnesium in our diet, we must take supplements. The best types of magnesium to take are magnesium citrate, malate, and chloride, because they are readily absorbed by the gut. Another source often encountered, but not recommended is magnesium oxide -- only 5% is absorbed, and the remainder causes a laxative effect. See Dean (2017) book below.

Calcium

To stay healthy: a total of 500-1000 mg/day. (3-*6 mg/pound/day for adults, more for teenagers' growth*). Calcium is an important nutrient for arteries, muscles, the digestive system, brain, blood cells, and bones. It is essential for all organs, and its deficiency contributes to a wide variety of symptoms including osteomalacia and osteoporosis. However it is best not to take calcium supplements. With an overdose of calcium, it is possible to get too high a level of calcium into the blood, especially if vitamin D level is high, but this effect is prevented

by adequate magnesium intake, and also by vitamin K2 (often in multivitamin supplements). Recent studies suggest it is better to get calcium from the diet rather than supplements. Calcium is excreted by the body when the amount of protein in the diet is greater than needed by the body to replenish its need for protein. This can deplete the body and bones of calcium, but the effect is countered by an adequate supply of magnesium. See Dean (2017), Khalsa (2009) books below.

To recover from deficit, eat foods containing calcium instead of taking supplements. It is important to balance the amount of calcium with a proportionate amount of magnesium, and also to take enough vitamin D which facilitates the absorption, regulation, and utilization of calcium. Most of us have had a magnesium deficit throughout our lives, and as we get older many of us have a calcium deficit, see Dean book below.

Sources of calcium: dairy products, dark green leafy vegetables, sardines and canned salmon (with bone), rhubarb, molasses, peas and beans, supplements: calcium is often combined with magnesium in a 2:1 ratio -- calcium carbonate is the most common form but is only ~30% absorbed, however calcium lactate/malate/citrate/aspartate/orotate is ~80% absorbed.

Vitamin B-3 (niacin)

To stay healthy: 20-1000 mg/day. Vitamin B-3 (niacin) is required for the metabolism of food, for the skin, digestive system, and the brain. It is required at higher doses than other B vitamins, and should be taken together with a separate multivitamin supplement that provides the entire B vitamin complex. Because our needs vary, many people are deficient, causing a wide variety of symptoms. Niacin is widely used to increase HDL and reduce LDL cholesterol, and to help relax, reduce anxiety and depression, brain health, and get to sleep. It is also helpful to prevent inflammation and for arthritis and multiple sclerosis (see Saul [2012], Hoffer & Saul [2008], and Hoffer et al. [2012] books below). Good sources are brewer's yeast, fish, meat, legumes, nuts, seeds, and green leafy vegetables. Niacin taken alone can cause a warm flush on the skin for a few minutes which is harmless, and associated with this can be a slight temporary rise in blood sugar. However, niacin when taken with vitamin C has many beneficial effects, and maintains a lower level of blood sugar, important for diabetics to reduce the need for insulin. When starting niacin, purchase 100 mg tablets, break them into quarters, and take these 25 mg doses one per day, slowly building up to 2, then 3 per day, taken with meals. For many people this will prevent a flush, so that higher doses are possible within a few days, for example 50 mg taken twice per day, then working up to 100 mg taken once, then twice or three times per day. With each dose the niacin flush becomes less intense and then is only a minor nuisance. Over several months, it is helpful to ramp up to a dose of 500 mg taken 2-3 times per day. These will give a skin flush at first but taken continually the flush isn't too bad. Niacin has an anti-viral effect taken at a saturation level just below what causes a flush -- and this level varies between individuals (see Hoffer & Saul [2008] and Hoffer et al. [2012] books below). Niacinamide generally does not cause a niacin flush but it also does not reduce cholesterol. Time-release forms of niacin are available that reduce the tendency for flushing, but these are more expensive and some require a prescription. Those with diabetes, liver problems, or who drink alcohol or are pregnant should check with their doctor when using niacin. In rare cases, high doses of niacin (greater than 1500 mg/day) can cause other problems, such as macular edema or blurred vision. These symptoms are reversed by taking a lower dose. Typical doses for niacin saturation are 100-2000 mg/day, taken in divided doses to reduce the niacin flush and because niacin is water-soluble and is readily eliminated from the bloodstream.

Vitamin B-12 (cobalamins, methylcobalamin)

To stay healthy: 20-100 mcg/day (a millionth of an ounce). Vitamin B-12 is required for the metabolism of

every cell in the body, and is necessary to regenerate folate, another B vitamin. A deficiency of vitamin B-12 can cause a variety of symptoms, including fatigue, tremor, numbness or tingling in extremities, peripheral neuropathies, balance problems, depression, and memory loss, and with a more serious deficiency pernicious anemia, cognitive impairment, and permanent brain damage. When taken along with vitamins B-6, and B-9 (folate), vitamin B-12 has been shown to reduce brain atrophy in older people (Smith et al., 2010). Deficiency is common, because 25% to 50% of adults are deficient, and the problem increases with age (50% or more are deficient over the age of 60) because of absorption problems. Vitamin B-12 uptake by the gut is more complicated than for other vitamins, and requires a special protein binding factor and a transporter to capture the small amount in food. Vitamin B-12 is made by bacteria, not by plants or animals. It is found in meat, fish, poultry, dairy products, and eggs, and excellent sources are shellfish, liver, sardines, and salmon. For those on a vegetarian diet or with special problems, a vitamin B-12 deficiency is common, and may require taking a supplement containing more than a standard multivitamin tablet. Although the recommended amount of vitamin B-12 is 6 mcg/day, taking a supplement tablet of 100-1000 mcg is safe and may be necessary because in many people it is not well absorbed. For oral supplements, methylcobalamin is considered more effective than cyanocobalamin. The body normally stores enough vitamin B-12 for several years, so a dietary deficiency may take more than a year to be noticed. A very effective diagnostic for vitamin B-12 deficiency is the urinary MMA test, paid for by most medical insurance. See Pacholok & Stuart (2006) book.

Omega-3 fatty acids (ALA, DHA, EPA).

To stay healthy, 1000-4000 mg/day. *(10-20 mg/lb/day).* Omega-3 and omega-6 oils (polyunsaturated fatty acids) are essential for growth, and for maintenance of cells throughout the body, and especially the brain, for use in cell membranes and biochemical reactions. A deficit of omega-3 oils is very common because most cooking oils, made from seed oils (corn, soy, canola), are high in omega-6 oils but low in omega-3 oils. An omega-3 deficit is thought to be a contributing factor to heart disease, brain diseases, and aging throughout the body. Omega-3 oils include alpha-linolenic acid (ALA or LNA), and eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA). The body can make EPA and DHA from ALA, but only slowly, so although only ALA is essential, all 3 of these oils are helpful to prevent a deficiency. Note that alpha-linolenic acid is often confused with alpha-lipoic acid (a different but useful fatty acid that is a powerful anti-oxidant), because both are sometimes abbreviated as ALA. Also note that alpha-linolenic acid (an essential omega-3 oil) is different than alpha-linoleic acid (an essential omega-6 oil).

The ratio of omega-3 to omega-6 essential fatty acids in our diet is thought to be important, and historically the ratio was near to 1. However, in our modern diet, the amount of omega-6 is greater by a factor of ~15. This excess of omega-6 oils contributes to inflammation throughout the body, and is a risk factor for heart attacks and complications of diabetes. Although we all need some omega-6 oils in our diet, most of us need a lot more omega-3 oils to keep the balance right. Omega-3 oils can be obtained in oily fish (EPA and DHA: salmon, trout, tuna, anchovies, sardines, and mackerel), and range-fed beef, lamb, and chicken. Note that the smaller fish, e.g. anchovies and sardines, have the lowest content of toxins and heavy metals such as mercury. A 4 oz serving of oily fish gives a generous amount of omega-3 oils (salmon 1,000-1,500 mg, sardines and mackerel, 2,000-3,300 mg), and fish oil supplements are widely available in softgel capsules.

Omega-3 oils can also be obtained in some vegetable sources (ALA): flax oil, walnuts, lecithin, wheat germ. Flax oil is commonly used as it has a relatively high content of ALA, and many doctors advise eating a handful of walnuts at each meal as a source of ALA to help prevent heart disease. Note that flax oil (also known as linseed oil, found in oil paint) is highly reactive with oxygen, and can cause a fire from the heat of oxidation if left to dry in a tightly-crumpled rag or paper towel. Also note that commercial boiled linseed oil is not edible

because it contains metal additives. Flax oil goes rancid in 2-3 months in a bottle at room temperature with exposure to oxygen and/or light, so it should be kept in a black bottle in the refrigerator. When fresh it smells nutty; if it smells bad, it is going rancid. The softgel capsule form of flax oil is more stable and can stay fresh for as long as 6 months. Flax oil should not be used for cooking because the heat quickly oxidizes it, turning it to varnish. You can prevent a bottle of flax oil from going rancid so quickly by adding the contents of a few capsules of d-alpha-tocopherol (vitamin E, the non-acetate form). Freshly-ground flaxseed meal is a good alternative to flax oil because the seed coating protects it from getting rancid, and the whole seed has many other excellent nutrients. See Simopoulos & Robinson (1999), Saul (2012), Pollan (2006), Hoffer & Saul (2008) books below.

Iron

To stay healthy: 1-10 mg/day. Iron is necessary for most cells throughout the body, and thus is essential for health. Most of the iron in the body is bound to hemoglobin carried inside red blood cells and myoglobin in muscle cells. In this role, iron is essential to carry oxygen via the bloodstream to the body's tissues, and to remove carbon dioxide. Iron also is necessary for dozens of biochemical reactions in most cells, which depend on the iron-containing cytochromes to metabolize food for energy. A deficiency of iron causes anemia and a lack of energy, which can be insidious because it often has few other specific symptoms. But unlike most other nutrients, there is no known metabolic mechanism for active elimination of iron from the body, so it is easy and fairly common to get too much. Our bodies excrete about 1 mg of iron per day, in addition to elimination through blood loss, so we need to absorb at least this amount. However, too much iron can be unhealthy, for several reasons. Because there is no way for the body to actively eliminate iron, any excess in the blood is stored inside cells using the ferritin molecule, where it can be released when needed. However, if too much iron is absorbed over long periods, this can cause a toxic accumulation of iron, called "hemochromatosis", so it is important not to get too much. Further, excess iron can encourage bacterial growth in the bloodstream, and can also promote tumor growth, oxidative stress and aging. Without iron, bacteria and most other types of cells cannot grow, so blood contains iron-binding proteins that efficiently remove iron from blood plasma. For the same reason, human mother's milk contains almost no iron, cows milk contains very little, and lactobacteria that are beneficial to human digestion are one of the few types of bacteria that do not require iron. Excess iron consumption is thought to be a risk factor for bacterial infections and damage from free radicals during early development, and for many diseases of aging such as heart disease and macular degeneration (see Emery (1991) book and weblinks below). Whole grains contain IP6 (phytic acid) which binds metal ions and historically prevented iron and other metal overload diseases (see Saul (2012) book below).

Iron for women and infants. Women may lose ~60 mg/month of iron during menstrual periods, which must be made up from the diet on a regular basis. Also, during pregnancy, a women's body needs to supply iron to the fetus. Because the additional iron required by the fetus is beyond the normal requirement, some doctors advise extra iron during pregnancy. However, the menstrual loss is eliminated during pregnancy, which is equivalent to ~500 mg over the gestational period for a fetus, and thus in many cases not much additional iron is needed during pregnancy. The optimal amount of supplementary iron is a balance between the need to supply the fetus with its iron needs and prevent anemia, and the need to maintain low iron levels in the blood plasma to prevent infections and other diseases. Normal term breast-fed babies don't require any supplemental iron in their diet for their first 9-12 months. They can absorb ~1 mg/day from their normal feeding which is enough to maintain a positive iron balance. Because cow's milk contains less absorbable iron, babies fed on formula can get anemic without some iron supplementation, especially in their second 6 months. However, the iron added to infant formula is non-heme bound, which can be a risk factor for bacterial infections and damage from free radicals during early development. See your doctor for advice if you or your baby have special needs (see Emery (1991)

book below).

Sources of iron. The most absorbable form of iron is heme-bound iron, found in liver, red meat and turkey. Other good sources of iron include chocolate, beans and lentils, tomato sauce, and spinach. Daily multi-vitamin tablets for women contain ~20 mg of iron, and many other multi-vitamin tablets contain ~10mg (the RDA for men), and multi-vitamin tablets without iron are also available and recommended for men. The best forms of supplemental iron are ferrous fumarate, ferrous gluconate, ferrous ascorbate, or carbonyl iron (which is less absorbable but also less toxic). Avoid ferrous sulfate because it is not well absorbed and can cause constipation. Iron is also absorbed from acidic food cooked in unseasoned cast-iron skillets, up to ~5 mg/serving. The food may taste metallic so most cooks season their skillets with oil which reduces iron uptake. Vitamin C enhances the absorption of iron in the small intestine, so vegetable sources of iron may be sufficient if taken with several grams of vitamin C daily. Further, the body can prevent excess absorption of non-heme (vegetable) iron in the presence of vitamin C, so for this reason a vegetarian diet may be a safer way to get additional iron than eating meat. Many people, especially those who eat a lot of meat, get enough iron in their diet, and therefore should not take iron-containing supplements. However, those who give a lot of blood, or do heavy exercise or bleed a lot should consider taking supplemental iron. Also those with special problems should check with their doctor for advice. Many nutritionists and doctors recommend iron intake on the low side to combat infections and other consequences of iron overload. Blood tests for iron are readily available and recommended. See Emery (1991) book below.

Zinc

To stay healthy: 20-50 mg/day. (*0.25 mg/lb/day*) Zinc is utilized in dozens of enzymes for biochemical pathways, so it is an essential and important nutrient. It is an antioxidant and enhances the immune system in fighting viruses and bacteria, and it helps the body to . Zinc absorption can be inhibited by phytic acid (also called IP6; found in soybeans, legumes, seeds, and cereals), by oxalic acid (found in greens, berries, chocolate, tea, etc), by polyphenols (e.g. tannins, found in coffee and tea), by some vegetable fibers, and by iron and calcium. Taking a supplement of zinc can inhibit copper absorption, so when taking zinc supplements it is also advisable to take copper at a ratio of ~10%, e.g. capsules containing 50 mg of zinc along with 2 -4 mg of copper.

Sources of zinc: meat, fowl, liver are good sources. Oysters are excellent sources. Vegetable sources, such as barley, buckwheat, beans, and whole wheat flour contain lower levels of zinc.

Micro nutrients & minerals

To stay healthy: eat a varied diet, focused on moderate amounts of meat, fowl, or fish, dark green leafy and colorful vegetables, whole-grain foods, legumes, fruits, and nuts, take a daily mega-multivitamin that includes B-complex vitamins (B1,B2,B3,B5,B6) at a dose of 50 mg or more, and use sea salt because it contains micro-minerals. Some care is required for vitamin A because it can be toxic if taken long-term at a 5-fold normal dose. Beta-carotene (provided by carrots) is a solution to this problem because it is non-toxic and can supply our requirement for vitamin A. Avoid foods with high levels of sugar or carbohydrates; instead include portions of fat (butter, animal fat, avocado, etc) which is more satisfying to the appetite. If you get adequate doses of vitamins (esp. vitamin C and E), dietary fat does not cause cardiovascular disease. If you're eating a vegetarian diet, take a multivitamin with iron, but if you regularly eat meat, take a multivitamin without iron. Many other nutrients and minerals are necessary at low doses, some very likely unknown. Selenium is an important antioxidant and is helpful in preventing viral infections. It is included in many multivitamins at a dose of 50-

100 mcg. Wheat germ and brewer's yeast are good sources of protein, B vitamins, magnesium, and trace minerals, and wheat germ is a good source of vitamin E. An excellent breakfast is 3/4 cup uncooked oats (1- or 5-min), 1/4 cup wheat germ, 1 tbsp lecithin granules, and 1 tbsp brewer's yeast, with 1/2 tsp dark brown sugar and a pinch of sea salt (to taste), served with milk or juice. Buckwheat is an excellent substitute for wheat and contains a high level of nutrients including magnesium. See lists of minerals and nutrients below.

To avoid metabolic syndrome: Minimize consumption of foods made from refined sugar, flour or oil (white or "wheat" bread, cake, cookies, standard pasta, salad dressing, white rice, etc), because these give calories without nutrients, and thus tend to cause obesity and nutrient deficits -- replace with moderate amounts of whole-grain equivalents ("whole-wheat" bread, pasta, brown rice). Avoid foods that contain sugar, high-fructose corn syrup, or processed juices with a high fructose content because fructose must be processed by the liver before it can be utlized by the body, and a large dose of fructose overwhelms the liver. Eating raw fruit is OK because its fructose is absorbed slower. Fat is OK, as it satisfies the appetite more than carbs. And take supplements for vitamin Bs, C, D, E, magnesium and zinc.

Healing hints

Allergies: Generous doses of vitamin C can greatly reduce or prevent allergic reactions (see Saul [2012] book). Oral doses (bowel tolerance, 1-5 gms/hour) of vitamin C can also help to reduce allergic skin rashes and other types of allergy. To reduce or prevent the skin rash and inflammation from poison ivy and insect bites, wet the skin and sprinkle with sodium ascorbate powder. Keep moistened by covering with a waterproof layer. The ascorbate is then absorbed directly into the skin. Also, generous application of vitamin E (d-alpha- or mixed tocopherols, not the acetate form) on the rash can help to reduce the inflammation. The vitamin E is absorbed over a period of hours and can then be reapplied. See **http://www.doctoryourself.com/allergies.html** (use of vitamin C to prevent allergies) and **http://www.doctoryourself.com/allergies_2.html**. (Advice on simple ways to prevent allergies).

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http://www.nlm.nih.gov/medlineplus/ency/article/002404.htm (official NIH description of vitamin C, but many experts say that the doses are 50-100x too low.)
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