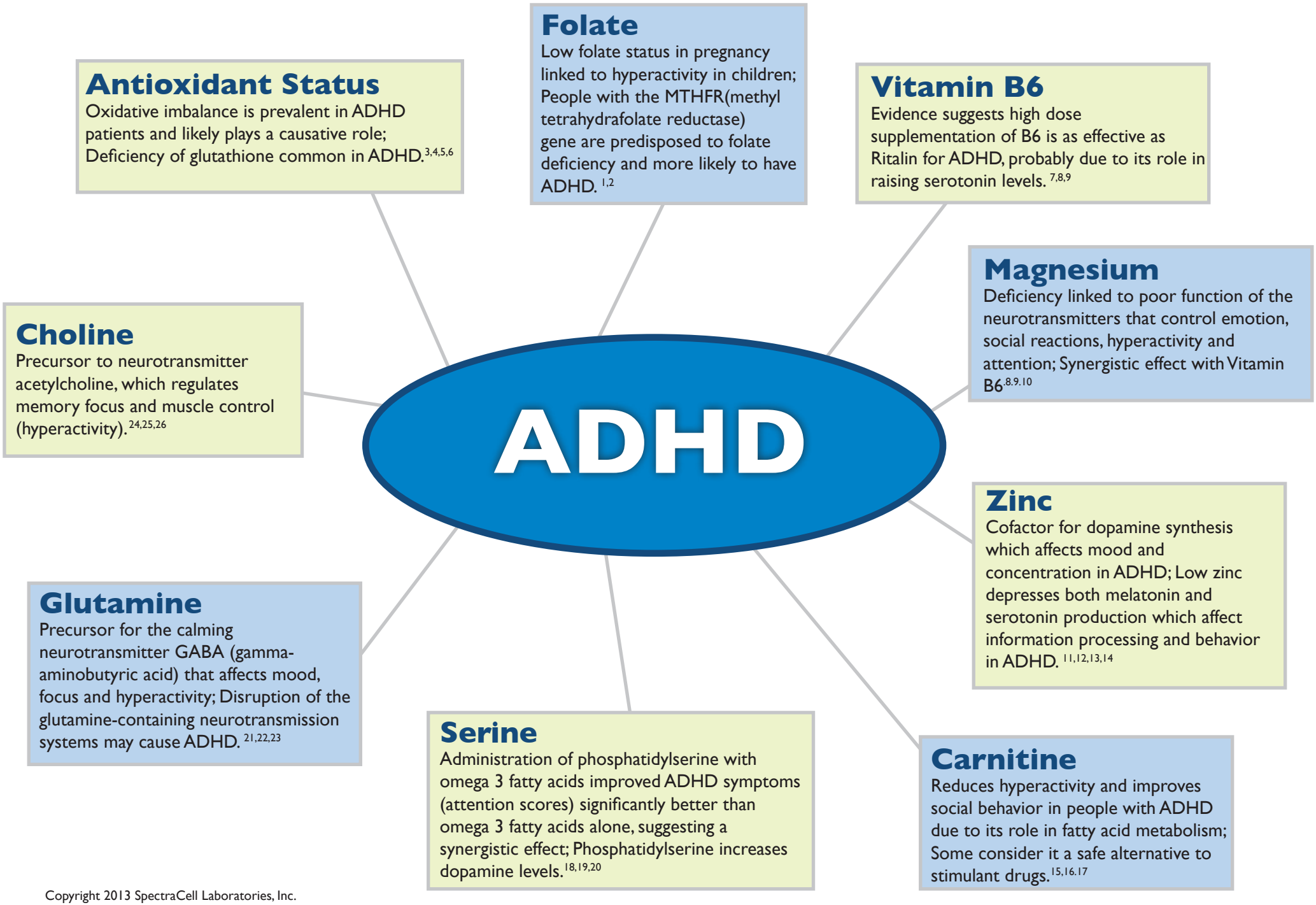
Nutrient Correlations

Deficiencies Correlated with Disease Conditions

SpectraCell Laboratories

Science + Health + Solutions



ADRENAL FATIGUE

Vitamin B5
Sometimes called the "anti-stress" vitamin, B5 (pantothenic acid) can reverse damage to overworked adrenal glands; Deficiency results in an inability to respond appropriately to physical or emotional stress.[1,33,34]

Vitamin C
Adrenal glands have the highest vitamin C of any tissue in the body; Supports adrenals and reduces cortisol; Depletion is very common in adrenal fatigue.[1,2,3,4]

Serine
Dose-dependently buffers the adrenal response to physical and mental stress, thus protecting the body and mind against cellular damage from chronically high cortisol.[1,5,6]

Carnitine
May reduce cortisol levels by keeping the stress response (also known as HPA activation*) in check.[7,8,9] *HPA= hypothalamic-pituitary-adrenal

Vitamin B1, B2, B3
The adrenal glands are extremely metabolically active due to the constant production of hormones – B vitamins regulate and support this process.[1,2]

Magnesium
Regulates the system (called the HPA axis) that controls physical and psychological reactions to stress.[10,11]

Vitamin B6
Chronic stress can deplete B6, which is an important cofactor to several enzymes found in healthy adrenal glands.[1,32]

Selenium
Cofactor to a very potent enzyme (glutathione peroxidase) that restores adrenal function.[2,12,13,20]

Vitamin B12
Shifts the circadian rhythm of cortisol secretion back to normal, thus alleviating one of the major symptoms caused by adrenal fatigue– insomnia.[1,30,31]

Coenzyme Q10
Secretion of adrenal hormones will influence Coq10 levels, which are often low in people with adrenal fatigue (hypoadrenalism).[14,15]

Vitamin A
Reduces damage caused by stress hormones; Deficiency causes structural changes to adrenal glands that compromise its function.[27,28,29]

Inositol
Sometimes called vitamin B8, inositol regulates adrenaline-induced stress responses; Cortisol increases the body's inositol requirement.[16,17,18]

Glutathione & Cysteine
Adrenal glands need high amounts of this antioxidant (and its precursor cysteine) to prevent stress-induced or age-related adrenal fatigue.[2,20,26]

Vitamin D
Actually a hormone, vitamin D is the precursor to steroid hormones made by adrenals such as DHEA, cortisol and aldosterone.[24,25]

Vitamin E
Protects against age-related decline in adrenal function; The ability to synthesize key steroid hormones in the adrenals is greatly diminished by vitamin E deficiency.[2,20,23]

Lipoic Acid
Breaks down adrenal hormones so they no longer cause the "fight or flight" feelings associated with stress.[21,22]

Zinc, Copper, Managanese
As the adrenals make hormones, they are subjected to massive amounts of damaging free radicals, which are neutralized by a family of enzymes (superoxide dismutase) that requires these minerals; Deficiency in even one mineral cofactor may impair the adrenal glands' ability to make hormones.[2,19,20]

Additional nutrients affect adrenal function. This list is non-exhaustive.

ANXIETY

Carnitine
Studies show that carnitine can reduce anxiety and improve feelings of well being.[28,29]

Chromium
Its effect on serotonin transmission may explain its anxiolytic (anxiety relieving) effect in animal studies.[30,31]

Folate
Aids in production of neurotransmitters such as dopamine and serotonin, which have a calming effect on mood.[19,32,33]

Inositol
A neurochemical messenger in the brain, inositol (vitamin B8) affects dopamine and serotonin receptors; Trials confirm it is very effective in reducing panic attacks.[1,2]

Choline
Precursor to the neurotransmitter acetylcholine, which affects focus and mood; Low levels of choline linked to anxiety.[3,4]

Vitamins D and E
Low vitamin D status is linked to anxiety; Animal studies confirm the role of vitamins D and E in reducing anxiety-related behavior.[24,25,26,27]

Serine
Exerts a calming effect by buffering the adrenal response to physical or emotional stress; Lowered anxiety scores of patients with post traumatic stress disorder.[5,6,7]

Vitamin B3
One of the symptoms of severe B3 deficiency (pellagra) is anxiety; Pharmacological doses of B3 may enhance the calming effects of GABA in the brain; Converts tryptophan to serotonin.[19,22,23]

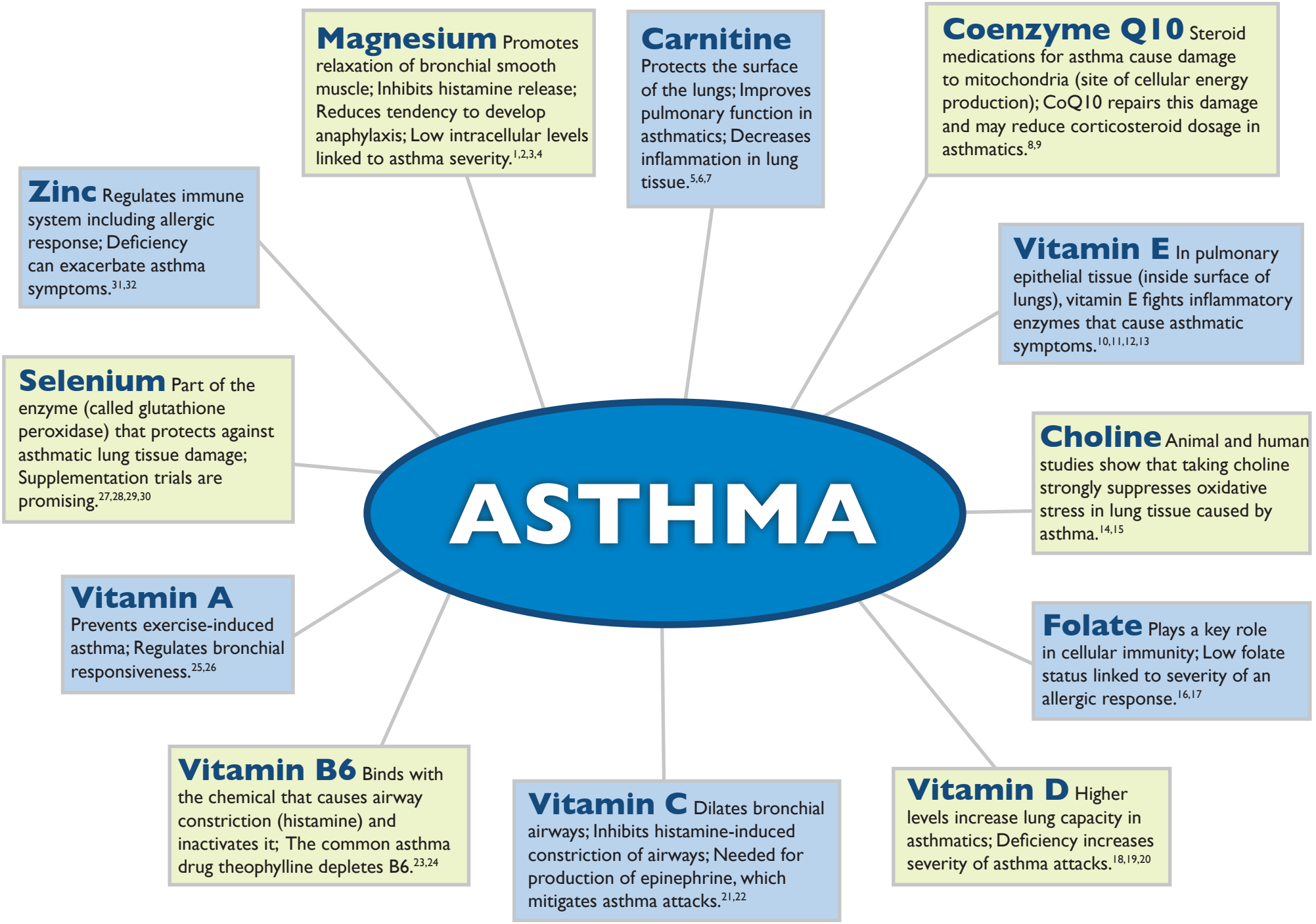
Copper
Integral part of certain chemicals in the brain (such as endorphins) that calm anxious feelings; Anxiety-like behavior may be exacerbated with copper deficiency.[8,9,10]

Vitamin B6
Cofactor in synthesis of calming neurotransmitters such as GABA (gamma-aminobutyric acid), serotonin and dopamine.[19,20,21]

Zinc
Reduces anxiety in clinical trials, possibly due to its interaction with NMDA (N-methyl-D- aspartate) receptors in the brain which regulate mood.[16,17,18]

Selenium
Repletion of selenium to normal levels reduced anxiety scores in clinical trials; Some suggest the mechanism of action is due to its role in key regulatory proteins (selenoproteins).[14,15]

Magnesium
Regulates the HPA (hypothalamic-pituitary adrenal) axis which controls physical and psychological reactions to stress; Deficiency can induce anxiety and emotional hyper-reactivity.[11,12,13]



AUTISM

Vitamin A
One cause of autism may be a defect in a retinoid receptor protein (G-alpha protein) which is critical for language processing, attention and sensory perception; Evidence suggests natural vitamin A fixes this protein defect in autistics.[1,2]

Vitamin D
High dose vitamin D therapy reversed autistic behaviors in severely deficient children; Maternal vitamin D deficiency may predispose children to autism.[3,4,5]

Carnitine
Transports fatty acids into cells; Low carnitine (common in autism) impairs the ability to use fatty acids for learning and social development.[6,7]

Zinc
Eliminates toxic mercury from brain tissue; Zinc/ copper ratio is particularly low in autistic kids; Low zinc impairs the protein (called metallothionein) that removes heavy metals from the body.[8,9,10]

Magnesium
Cofactor for the neurotransmitters that affect social reactions and emotion; Autistics have low levels; Improves effectiveness of B6 therapy.[11,12,13]

Folate
Oral folate therapy can resolve symptoms of autism in some cases, particularly in autistics with genes that impair folate dependent enzymes.[31,32,33]

Vitamin B6
Cofactor the neurotransmitters serotonin and dopamine; Conversion of B6 to its active form is compromised in many autistics; Supplementation trials with B6 resulted in better eye contact, speech and fewer self-stimulatory behavior in autistics; Some consider B6 in combination with magnesium to be a breakthrough treatment for autism.[14,15]

Glutamine
Blood levels of this amino acid which acts as a neurotransmitter are particularly low in autistics. Glutamine also helps prevent leaky gut syndrome, which can exacerbate autistic symptoms.[28,29,30]

Vitamin B12
Low B12 impairs methylation (detoxification) which causes the neurological damage responsible for many autistic symptoms; Deficiency of B12 can cause optic neuropathy and vision loss in autistics; B12 raises cysteine and glutathione levels.[16,17,18]

Vitamin C
Improved symptom severity and sensory motor scores in autistic patients possibly due to interaction with dopamine synthesis; Vitamin C also has a strong sparing effect on glutathione.[26,27]

Vitamin B1
Deficiency linked to delayed language development; Supplementation may benefit autistic patients.[19,20]

Glutathione & Cysteine
Commonly deficient in autistic patients, lack of these antioxidants impair detoxification and methylation processes; Low levels linked to neurological symptoms in autism which is often considered an oxidative stress disorder.[21,22,23,24,25]

DEPRESSION

Selenium
Integral part of regulatory proteins (selenoproteins) in the brain; Supplementation trials are promising; May alleviate postpartum depression.[5,6]

Chromium
Elevates serotonin (feel-good neurotransmitter) levels in the brain; May be particularly effective on eating symptoms of depression such as carbohydrate craving and increased appetite, due to its effect on blood sugar regulation.[37,38,39]

Folate
Building block for many "feel-good" neurotransmitters such as serotonin, dopamine and norepinephrine; Low folate causes poor response to anti-depressant meds; The lower the folate, the more severe the depression.[7,8,9,10]

Magnesium
Deficiency damages NMDA (N-methyl-D-aspartate) receptors in the brain, which regulate mood; Well-documented anti-depressant effects.[1,2,3,4]

Vitamin B12
Depression may be a manifestation of B12 deficiency; Repletion of B12 to adequate levels can improve treatment response; B12 deficiency common in psychiatric disorders.[11,12,13]

Zinc
Improves efficacy of antidepressant drugs; Particularly useful for treatment resistant patients; Regulates neurotransmitters.[33,34,35,36]

Vitamin B6
Cofactor for serotonin and dopamine production (feel good chemicals); Studies indicate that low levels may predispose people to depression.[14,15,16]

Serine
Regulates brain chemistry; Involved in NMDA receptor function; Acts as a neurotransmitter; Low levels correlate with severity of depression.[31,32]

Vitamin B2
Low B2 has been implicated in depression due to its role in methylation reactions in the brain.[17,18]

Antioxidants
Oxidative stress in the brain alters neurotransmitter function; Antioxidants protect our brain, which is very sensitive to oxidation; Several antioxidants – Vitamins A, C and E, Lipoic Acid, CoQ10, Glutathione and Cysteine – play a key role in prevention and treatment of depression.[28,29,30]

Vitamin D
Clinical trials suggest increasing blood levels of vitamin D, which is actually a hormone precursor, may improve symptoms of depression.[19,20,21]

Inositol
Influences signaling pathways in the brain; Particularly effective in SSRI (selective serotonin reuptake inhibitor) sensitive disorders.[24,25]

Carnitine
Increases serotonin and noradrenaline which lift mood; In trials, carnitine alleviates depression with few, if any, side effects.[22,23]

Biotin
Part of the B-vitamin complex, biotin deficiency has induced depression in animal and human studies.[26,27]

DIABETES

Vitamin B12
Deficiency common in diabetics because metformin depletes B12.[1,2]

Vitamin B3
Preserves B-cell function in type 1 diabetics; Part of GTF (glucose tolerance factor) which facilitates insulin binding.[3,4,5]

Vitamin D
Lowers risk of type 1 and 2 diabetes; Supresses inflammation of pancreatic B-cells; Vitamin D receptor gene linked to diabetes.[6,7,8]

Vitamin E
Confers protection against diabetes by protecting pancreatic B-cells from oxidative stress induced damage; May prevent progression of type 1 diabetes.[6,9]

Chromium
Helps insulin attach to cell's receptors increasing glucose uptake into cell; Deficiency can cause insulin resistance; Supplementation trials show dose-dependent benefits for type II diabetics.[36,37,38]

Vitamin C
Lowers glycolysated hemoglobin (HbA1c) and fasting and post-meal glucose levels and in type 2 diabetics.[10,11,12]

Biotin
Stimulates glucose-induced insulin secretion in pancreatic B-cells; High dose biotin can improve glycemic control in diabetics.[33,34,35]

Inositol
Evidence suggests that inositol may be effective in treating diabetic neuropathy.[13,14]

Carnitine
Reduces and even prevents pain from diabetic neuropathy; Improves insulin sensitivity by increasing glucose uptake and storage.[15,16,17,18]

Magnesium
Deficiency reduces insulin sensitivity; Low magnesium exacerbates foot ulcers in diabetics.[31,32]

Glutamine
Stimulates a hormone called GLP-1 (glucagon-like peptide 1) that regulates insulin secretion after meals; Improves insulin signaling and sensitivity.[19,20]

Zinc
Needed in the synthesis, storage and secretion of insulin; Protects pancreatic B-cells from damage; Affects the expression of genes linked to diabetes.[29,30]

Lipoic Acid
Enhances glucose uptake in skeletal muscle tissue; Improves glucose tolerance in type 2 diabetics; Very effective treatment for diabetic neuropathy.[26,27,28]

Glutathione & Cysteine
Glutathione-containing enzymes protect B-cells which are particularly sensitive to oxidative stress; Type 2 diabetics have abnormal antioxidant status; Supplementation with the glutathione precursor cysteine restores antioxidant status.[23,24,25]

Coenzyme Q10
Protects kidney from diabetes related damage; Improves glycemic control in type 2 diabetics.[21,22]

DYSLIPIDEMIA

Manganese
Cofactor to an antioxidant (superoxide dismutase) that repairs damage to blood vessels caused by oxidized LDL (low density lipoprotein). [1,2]

Magnesium
Deficiency causes pro-atherogenic (heart-disease causing) changes in lipoprotein metabolism; Protects LDL (low density lipoprotein) from being oxidized. [3,4]

Vitamin C
Protects LDL from oxidation, thus making it less "sticky" and prone to atherosclerosis (clogging of arteries); Prevents white blood cells (monocytes) and oxidized LDL from sticking to blood vessel wall; Lowers Lp(a) in some people. [5,6,7]

Vitamin D
Suppresses foam cell formation thus reducing risk of lipid-related arterial blockages; Deficiency linked to dyslipidemia. [8,9]

Zinc
Suboptimal zinc raises dangerous lipoproteins that promote vascular inflammation and arterial plaque formation; Cellular zinc controls the gene that makes heart-protective HDL (high density lipoprotein). [34,35,36]

Vitamin B3
Niacin (B3) effectively lowers the highly atherogenic Lp(a) by decreasing its rate of synthesis in the liver. [10,11]

Selenium
Prevents post-prandial (after a meal) changes in lipoproteins that make them susceptible to oxidation and thus harmful. [32,33]

Vitamin B5
Favorably alters low density lipoprotein metabolism and reduces triglycerides; Full benefit of lipid lowering effects may not be seen for up to four months. [12,13]

Copper
Several copper-dependent enzymes affect lipoprotein metabolism; Deficiency contributes to fatty buildup in arteries caused by dyslipidemia. [29,30,31]

Carnitine
In supplementation trials, carnitine lowers triglycerides, oxidized LDL and the atherogenic Lp(a); This effect is likely due to its role in transporting fatty acids into cells so they can be used as fuel. [14,15,16]

Coenzyme Q10
It is well established that statins, often prescribed for dyslipidemia, deplete CoQ10; Lowers Lp(a) and improves efficacy of some dyslipidemia meds. [27,28]

Chromium
Specifically improves the dyslipidemia that accompanies insulin resistance; May increase HDL; Synergistic effect with niacin (B3) for dyslipidemia. [24,25,26]

Choline
Regulates HDL metabolism; Part of the enzyme lecithin-cholesterol acyltransferase that has a major impact on lipoprotein metabolism. [22,23]

Inositol
Decreases small, dense LDL especially in patients with metabolic syndrome; Lowers triglycerides. [19,20,21]

Lipoic Acid
Improves lipid profile by reducing small, dense LDL (dangerous type); Protects vascular lining from oxidized cholesterol. [17,18]

Additional nutrients affect lipid metabolism. This list is non-exhaustive.

Estrogen

Cysteine
Prevents oxidation of estrogen into a dangerous form that causes breast cancer. [29,30,31]

Choline
Estrogen stimulates the breakdown of phosphatidylcholine (cell membrane) so those with low estrogen (postmenopausal women) require more choline; Detoxi es excess estrogen via methylation pathway.[1,32,33]

Folate
De ciency reduces estrogen levels; Excess folate is linked to some types of estrogen-related breast cancer; Detoxi es excess estrogen via methylation pathway; Regulates estrogen's effect on genes.[1,2,3]

Zinc
Estrogen lowers risk of zinc de ciency; Zinc dependent proteins metabolize estrogen. [26,27,28]

Vitamin B6
Protects genes from estrogen-induced damage thus lowering risk of hormone related cancers; Detoxi es excess estrogen via methylation pathway; Estrogen-based oral contraceptives cause B6 de ciency.[4,5,6,7]

Magnesium
Cofactor for the enzyme that removes toxic forms of estrogen (catechol-O-methyltransferase); Estrogen alters magnesium levels throughout menstrual cycle. [1,24,25,26]

Vitamin D
Regulates synthesis of estradiol and estrone; Enhances estrogen's protective effect on bones. [8,9,10]

Selenium
Estrogen levels affect how selenium is distributed to various tissues in the body. [22,23]

Vitamin C
Increases the most potent estrogen (estradiol) in women on hormone therapy; Lowers aromatase (enzyme that converts testosterone to estrogen) in ovaries. [11,12,13]

Calcium
Calcium-D-glucarate lowers estradiol levels; Helps breakdown estrogen in the liver and convert it to a less toxic form. [1,20,21]

Vitamin K
Inhibits estrogen activity by binding to estrogen receptors; Lowers the ratio of estradiol (strong estrogen) to estrone (weaker estrogen). [14,15]

Vitamin A
Helps metabolize the biologically active estrogen (estradiol) to an inactive form (estrone). [18,19]

Vitamin E
De ciency impairs estrogen detoxi cation pathway; Some forms of vitamin E inhibit estrogen action, especially in breast tissue; Low levels linked to higher estrogen. [1,16,17]

FATIGUE

Carnitine Transports fatty acids into mitochondria; Decreases both mental and physical fatigue in clinical trials.[15,31,32]

Chromium Promotes glucose uptake into cells, helping stabilize blood sugar.[16,33]

Zinc Deficiency lowers immunity and may cause muscle fatigue; Involved in several reactions for energy metabolism.[15,34,35]

Asparagine Supplementation of this amino acid delayed fatigue during exercise by decreasing the rate at which glycogen was used up; needed for gluconeogenesis, a process that allows glucose to be made from protein to prevent blood sugar from getting too low.[1,2,3]

B Vitamins Necessary for converting food into energy; Cofactors in the mitochondrial respiratory chain include B1, B2, B3, B5, B6, B12 and Folate.[8,15,16,26-30]

Biotin Helps liver utilize glycogen for energy. Animal studies confirm that biotin deficiency causes clinical fatigue.[4]

Vitamin D Low levels are seen in patients with chronic fatigue syndrome; Deficiency causes reduced muscle strength.[24,25]

Glutamine Mental and physical fatigue coincides with reduced levels of this amino acid in various tissues. Supplementation makes muscle more sensitive to insulin, increasing energy levels.[5,6,7]

Vitamin E Inverse correlation exists between fatigue and vitamin E levels.[23]

Serine Counteracts the overproduction of fatigue-causing stress hormones.[8,9]

Vitamin A When cellular levels of vitamin A are low, mitochondrial respiration and ATP production decreases.[22]

CoQ10 Deficiency causes fatigue due to its role in mitochondrial energy metabolism; therapeutic benefits particularly noticeable in chronic fatigue syndrome.[10,11,12,15]

Vitamin C Assists iron uptake and transport; Precursor to carnitine and several hormones that affect energy levels. Supplementation reduced fatigue in various trials.[15,16,21]

Antioxidants Several studies confirm that oxidative stress exacerbates clinical symptoms of fatigue. Mitochondrial dysfunction (inefficient energy metabolism) can be treated therapeutically with antioxidants such as Selenium, Cysteine, a-Lipoic acid and Glutathione, of which unusually low levels are seen in chronic fatigue patients.[12,16,18,19,20]

Magnesium Required to store energy molecule ATP; Repletion of magnesium in chronic fatigue patients shows clinical improvement in energy levels.[15,16,17]

Fructose Intolerance Fatigue (and hypoglycemia) are classic symptoms of this condition, since it depletes the main form of cellular energy, ATP.[13,14]

Female Fertility

Folate
Protects genes during rapid cell division which increases likelihood of a healthy embryo (via methylation of DNA); Deficiency raises homocysteine which damages reproductive cells.[1,2,3,4]

Vitamin B_6 & B_{12}
Both are needed to convert toxic homocysteine to a benign form; Low homocysteine levels linked to a better chance of pregnancy.[5,6,7,8]

Vitamin C
Increases serum progesterone levels; Induces ovulation in some women; Enhances effect of the fertility drug clomiphene.[9,10,11,12]

Minerals
Several enzymes needed to protect a woman's reproductive organs (such as superoxide dismutase) are dependent on the trace elements **zinc, copper and magnesium**.[22,30,31,32]

Vitamin D
Higher levels linked to better success rates of IVF (in vitro fertilization); Influences production of the sex hormones estradiol and progesterone.[13,14,15]

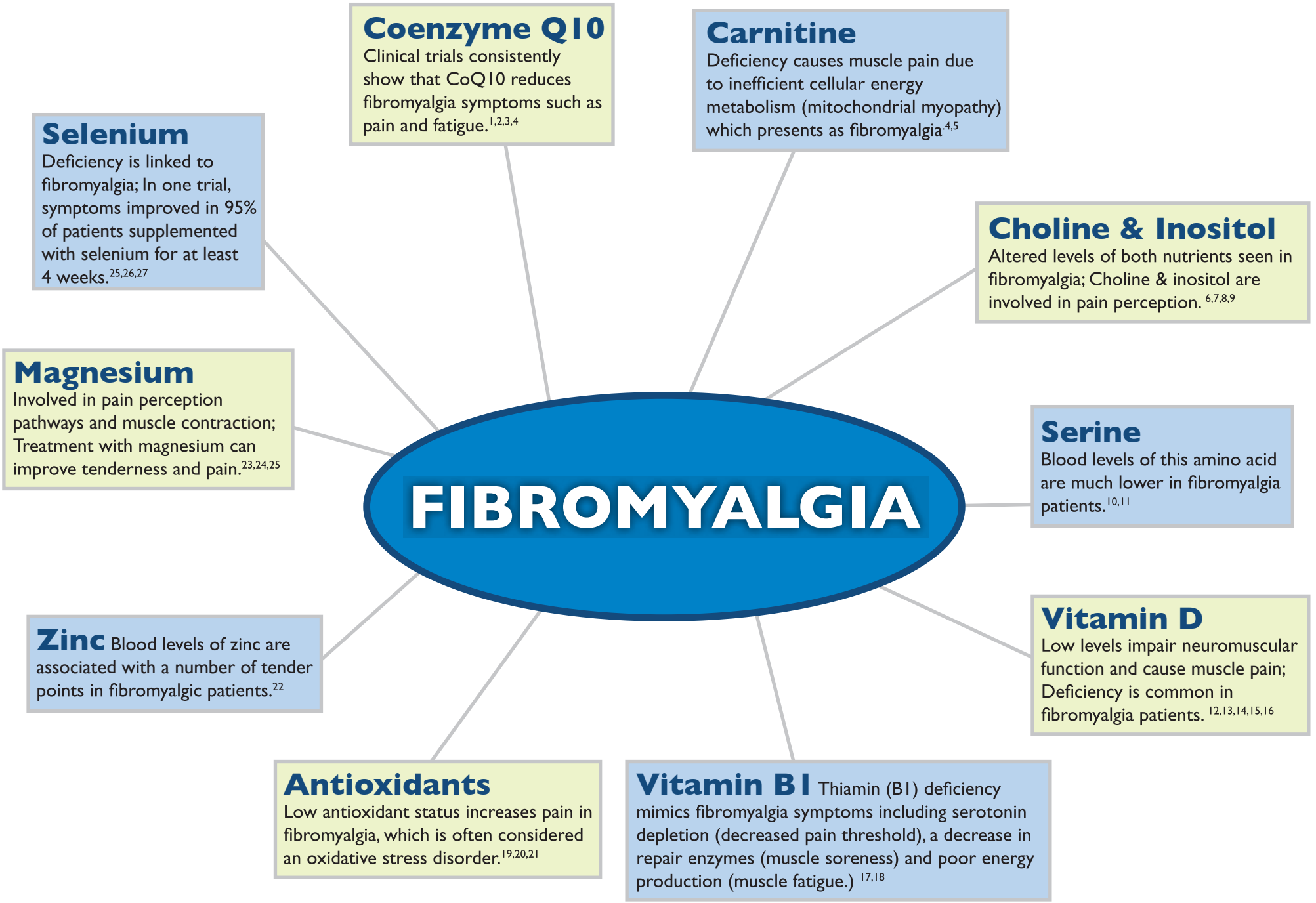
Vitamin E
Protects reproductive cells (follicles); May improve endometrial response (ability of fertilized egg to implant into uterine wall properly) during IVF.[16,17,18,19]

Antioxidant Status
Reproductive cells, including embryos, are very susceptible to damage from oxidative stress due to the rapid rate of growth; Low antioxidant status can cause infertility or miscarriage.[19,22,28,29]

Cysteine
N-acetyl cysteine can improve ovulation and pregnancy rates in women with infertility due to PCOS (polycystic ovary syndrome) that do not respond to fertility drugs; Improves viability of endometrial cells in vitro; Precursor to glutathione.[25,26,27]

Glutathione
Protects eggs (fertilized or not) from damage by reactive oxygen species; Protective action of follicle stimulating hormone on embryonic development is due largely to glutathione synthesis.[22,23,24]

Selenium
Deficiency implicated in miscarriage and infertility; In one trial, 100% of infertile women achieved pregnancy after supplementation.[20,21]



GASTROINTESTINAL HEALTH

Glutathione
Counteracts oxidative stress in the intestinal mucosa (gut wall); Recycles antioxidants such as vitamins C & E.[1,2,3]

Selenium
Cofactor to glutathione peroxidase (GPx), which protects intestinal wall from inflammatory damage; Lower GPx activity due to selenium deficiency is very common in people with gut inflammation.[3,4,5]

Glutamine
Preferred fuel for enterocytes (small intestine cells), which use the most glutamine in the entire body; Keeps the junctions between intestinal epithelial cells tight so foreign proteins cannot enter bloodstream.[6,7,8]

Zinc
Decreases intestinal permeability; Maintains integrity of intestinal wall, especially when inflammatory chemicals (TNFα) compromise epithelial lining; Works with vitamin A in regenerating cells that line the gut.[9,10,11]

Vitamin A
Regulates growth of epithelial cells, including those that line the gastrointestinal (GI) tract; Reduces inflammatory proteins in the gut.[12,13]

Lipoic Acid
Supresses damaging chemicals (cytokines) in GI tract that cause an inflammatory immune response; Preserves glutathione levels and recycles vitamin C.[35,36]

Vitamin C
An inflamed gut uses up the antioxidant vitamin C faster than a healthy gut; Promotes tissue healing in GI tract; Reduces gastrointestinal inflammation.[14,15]

Magnesium
Deficiency affects the amount of good bacteria found in the gut; May help prevent stomach ulcers; Insufficient levels are very common in people with irritable bowel; Antacids induce magnesium deficiency.[32,33,34]

Vitamin D
Keeps gut flora healthy by protecting good bacteria; Activates adaptive immunity that originates in GI tract; Promotes gut barrier integrity; Deficiency linked to inflammatory bowel disease flare-ups.[16,17,18]

Choline
Maintains the barrier function of gastric epithelium (helps prevent stomach ulcers) via its role in building cell membranes and acting as a surfactant in the GI tract.[30,31]

Vitamin K
Synthesized by intestinal bacteria; Deficiency common in chronic GI disorders; Bone demineralization that occurs with inflammatory bowel diseases (Crohn's, etc) is caused by vitamin K deficiency since it is a required cofactor for bone formation.[19,20]

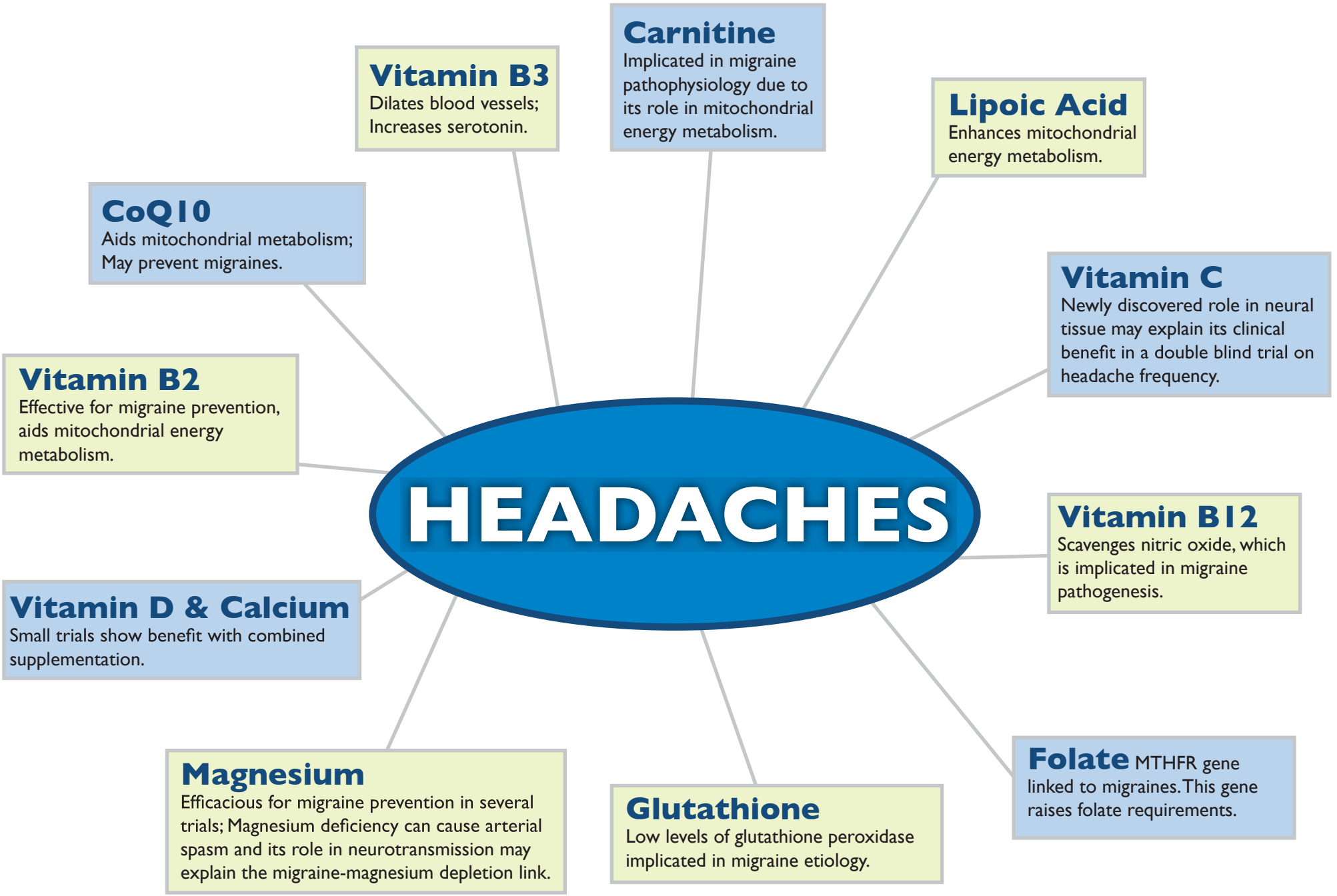
Folate
Deficiency alters genes in a way that makes colon cells more likely to become cancerous.[28,29]

Vitamin B6
Deficiency is strongly linked with a higher risk of developing colon cancer.[26,27]

Carnitine
May be therapeutically beneficial in people with colitis (inflammation of colon) due to its role in fatty acid metabolism, which is often impaired in GI disorders.[23,24,25]

Vitamin B12
Improves gastrointestinal complaints in some patients with dyspepsia (indigestion); Antacids deplete B12.[21,22]

Additional nutrients affect gastrointestinal health. This list is non-exhaustive.



Hypertension

Zinc Regulates angiotensin and endothelin, two enzymes that directly affect blood pressure; De ciency causes blood vessels to constrict. [37,38]

Glutathione Oxidative stress, which often manifests as glutathione de ciency, can induce hypertension. [39,40]

Biotin Pharmacological doses reduce systolic blood pressure by activating an enzyme (cGMP) that causes smooth muscle to relax. [1,2]

Vitamin A Suppresses the growth of vascular smooth muscle, thus keeping blood vessels (lumen) clear and wide. [3,4]

Copper Regulates enzymes that keep blood vessels dilating properly; Depletion causes hypertension; Supplementation trials positive. [34,35,36]

Vitamin B2 People with a certain gene (called MTHFR type TT) tend to respond well to B2 therapy for lowering blood pressure. [5,6]

Magnesium Promotes dilation of blood vessels; Low intracellular levels are a well established cause of hypertension. [31,32,33]

Vitamin B6 Lowers homocysteine, a toxin that makes arteries stiff and raises blood pressure; Low B6 is strongly linked to hypertension. [6,7,8,9]

Vitamin C Improves the ability of blood vessels to react appropriately to relaxation signals; Increases nitric oxide, a powerful vasodilator. [9,10,11,]

Calcium Optimal calcium status reduces vasconstriction; Particularly effective for salt-sensitive hypertension as it increases sodium excretion. [9,29,30]

Vitamin D Low vitamin D is strongly linked to hypertension, possibly due to its role in calcium transport; Augments blood pressure lowering effect of calcium; Keeps blood vessels smooth and healthy. [9,12,13]

Folate Lowers blood pressure by improving endothelial function, or the ability of blood vessels to properly dilate. [27,28]

Vitamin E Increases nitric oxide synthase, an enzyme that causes blood vessels to dilate; Protects blood vessels from damage. [14,15]

Carnitine Lowers blood pressure in the same way as ACE inhibitors, a common hypertension drug which reduces angiotensin, a substance that causes arteries to constrict; Its role in fat metabolism explains this effect. [25,26]

Coenzyme Q10 Improves bioenergetics of blood vessel wall; De ciency highly correlated to hypertension; Bene ts of CoQ10 often not seen for several weeks. [9,16,17]

Oleic Acid The bene ts of olive oil for blood pressure are largely due to its high oleic acid content, which protects endothelial cells (inner lining of blood vessels) from in ammation. [22,23,24]

Cysteine Anti-hypertensive effects stem from its role as a potent antioxidant; Effective vasolidator. [20,21]

Lipoic Acid Improves vascular tone; Causes vasolidation; Works like calcium channel blocker meds; Recycles vitamins C, E and Cysteine. [18,19]

Additional nutrients affect blood pressure.
This list is non-exhaustive.

HYPOTHYROIDISM

Glutathione
Hypothyroidism decreases efficacy of some antioxidants, such as glutathione peroxidase and superoxide dismutase.[1,2]

B Vitamins
A deficiency in B6, B12 or B9 (folate) can cause elevated homocysteine, which is linked with hypothyroidism. Folic acid levels have been linked to levels of thyroid stimulating hormone (TSH).[3,4,5,6,7]

Choline
Hypothyroidism negatively affects choline function in the brain, which can affect mood and cognition.[29,30]

Vitamin C and E
Partially restores thyroid function when liver detoxification ability is compromised.[2,8,9,10,11]

Lipoic Acid
Improves endothelial function in people with subclinical hypothyroidism; Protects thyroid cells from oxidative stress; May interfere with T4 therapy.[27,28]

Vitamin A
Activates gene that regulates TSH (thyroid stimulating hormone).[12,13,14]

Carnitine
Decreased tissue levels of carnitine in both hypo- and hyperthyroidism contribute to muscle fatigue.[24,25,26]

Zinc
Increases thyroid hormone T3 in deficient subjects.[15,16,17,20,21]

Asparagine
This amino acid is part of the structure of thyroid stimulating hormone which regulates communication with other hormones.[22,23]

Selenium
Converts thyroid hormones T4 (thyroxine) into T3 (triiodothyronine); Deficiency reduces T3 levels causing classic hypothyroidism symptoms such as fatigue, depression and/or weight gain.[18,19,20,21]

Copper
Low levels seen in experimentally induced hypothyroidism; Indirectly affects thyroid status by its antioxidant role via superoxide dismutase.[17]

INFLAMMATION

Selenium
Subclinical deficiency negatively alters genes that regulate the inflammatory response; Deficiency promotes vascular inflammation. [37,38]

Manganese
Cofactor to the powerful antioxidant superoxide dismutase that fights inflammation within cells. [1,2]

Magnesium
Deficiency activates pro-inflammatory chemicals called cytokines; Deficiency will also kick start a damaging immune response by activating cells called leukocytes and macrophages. [3,4,5]

Glutathione
Repairs damage to cells caused by inflammation; Regulates the production of pro-inflammatory cytokines; Recycles vitamins C and E. [6,7]

Cysteine
Protects organs such as blood vessels, brain and liver from inflammatory damage; Precursor to glutathione production; Supplementation with N-acetyl cysteine raises glutathione. [8,9]

Copper
Deficiency lowers enzyme activity (such as superoxide dismutase) that fights inflammation; Lowers damaging isoprostanes, a by-product of inflammation. [34,35,36]

Vitamin C
Low vitamin C linked to inflammation; Inversely related to C-reactive protein (CRP), a marker for systemic inflammation; Increases glutathione. [10,11,12]

Zinc
Inflammation raises demand for zinc; Pro-inflammatory chemicals (cytokines) dose dependently decrease in response to zinc repletion. [31,32,33]

Vitamin D
Potent modulator of inflammation; Helps turn off chronic inflammatory responses; Inhibits pro-inflammatory cytokine production. [13,14]

Vitamin A
Regulates the cellular immune response to inflammatory signals; Deficiency increases the severity of chronic inflammation; Zinc depletion lowers vitamin A status. [28,29,30]

Vitamin E
Limits destructive cell behavior caused by inflammatory enzymes gone wild; Reduces damage from tumor necrosis factor alpha (TNF-α); Deficiency predisposes a person to inflammation-related diseases. [15,16]

Vitamin B2
Riboflavin (B2) helps minimize pain associated with inflammation; Detoxifies homocysteine, an amino acid that indirectly causes inflammation in various tissues. [26,27]

Vitamin B6
Low B6 status is linked to high levels of CRP and systemic inflammation. [24,25]

Coenzyme Q10
Decreases several inflammatory markers (CRP and IL-6) in supplementation trials; Affects genes that control response to inflammatory stress. [21,22,23]

Glutamine
Decreases cytokine production; Invokes an anti-inflammatory response; Precursor to glutathione. [19,20]

Lipoic Acid
Neutralizes free radicals caused by uncontrolled inflammation in both water and lipid phases of the cell; Protects endothelial cells from inflammation; Regenerates other antioxidants such as vitamin E, C and glutathione. [17,18]

Additional nutrients affect inflammation. This list is non-exhaustive.

INSOMNIA

Vitamin B1
(Thiamin) In clinical trials, supplementation of healthy individuals that had marginal B1 deficiency improved their sleep.[1,2,3]

Vitamin B3
(Niacin) Increases REM sleep; Improves both quality and quantity of sleep by converting tryptophan to serotonin.[4,5]

Folate & Vitamin B6
Both are cofactors for several neurotransmitters in the brain such as serotonin and dopamine, many of which regulate sleep patterns.[4,6,7,8,9]

Vitamin A
Studies suggest vitamin A deficiency alters brains waves in non-REM sleep causing sleep to be less restorative.[24,25]

Vitamin B12
Normalizes circadian rhythms (sleep-wake cycles); Therapeutic benefits of B12 supplementation, both oral and intravenous, seen in studies.[10,11,12,13]

Oleic Acid
This fatty acid is a precursor of oleamide, which regulates our drive for sleep and tends to accumulate in the spinal fluid of sleep-deprived animals. Oleic acid also facilitates the absorption of vitamin A.[21,22,23]

Zinc & Copper
Both interact with NMDA (N-methyl-Daspartate) receptors in the brain that regulate sleep; A higher Zn/Cu ratio is linked to longer sleep duration.[15,19,20]

Magnesium
Improving magnesium status is associated with better quality sleep; Mimics the action of melatonin; Also alleviates insomnia due to restless leg syndrome.[14,15,16,17,18]

MALE FERTILITY

Zinc
Supplementation in men with low zinc status is often successful for male infertility; Deficiency lowers testosterone & reduces sperm count.[33,34,35]

Glutathione
Cofactor to the enzyme (glutathione peroxidase) that ensures structural integrity of sperm; Deficiency compromises sperm motility.[1,2,3]

Carnitine
Transports fatty acids, the preferred energy source of sperm, into cells; Significantly improves sperm motility in clinical trials.[4,5]

Vitamin A
Regulates genes that control sperm production (spermatogenesis); Deficiency may lower sperm count.[6,7,8]

Selenium
Required for sperm maturation; Protects lipid shell encasing each sperm (prevents lipid peroxidation), which is especially important since sperm have a very delicate fatty acid composition.[30,31,32]

Vitamin D
Increases sperm motility; Induces acrosome reaction, a process where a sperm releases enzymes to allow fusion with an egg; Men with low vitamin D may have slower sperm.[9,10]

Vitamin C
Low levels increase damage to sperm's genetic material; Supplementation improved sperm count, motility and structure in human trials.[11,12,13]

Coenzyme Q10
Acts as a potent antioxidant protecting sperm from damage; Improves semen bioenergetics via its role in mitochondrial function (helps sperm remain viable); A direct correlation exists between CoQ10 and sperm count & motility.[27,28,29]

Vitamin E
Protects sensitive sperm cell membranes; Enhances sperm's ability to penetrate an egg.[14,15]

Copper & Manganese
Both are cofactors for superoxide dismutase (a very powerful antioxidant) that protects sperm from oxidative damage.[25,26]

Antioxidant Status
Sperm are highly susceptible to free radical damage to both their genetic material and cell membrane; Poor antioxidant status is a well documented cause of male infertility.[22,23,24]

Folate
Deficiency may reduce testosterone; Critical to sperm creation due to its role as a methyl donor in DNA synthesis; The MTHFR (methylenetetrahydrofolate reductase) C677T gene, which increases folate requirements, is a risk factor for male infertility.[19,20,21]

Vitamin B12
Needed for cellular replication, including spermatogenesis; B12 moves from blood to semen to assist in sperm production; May increase sperm count.[16,17,18,19]

Additional nutrients affect male fertility. This list is non-exhaustive.

METHYLATION

Vitamin B3
Maintains proper methylation of genes that suppress tumor formation and growth.[3,4,5,6]

Vitamin B6
Cofactor for the enzyme (serine hydroxyl methyl transferase) that transfers methyl units.[7,8]

Vitamin B12
B12 is a key enzyme needed in the synthesis of S-adenosylmethionine (SAMe), the body's most important methyl donor. Methionine synthase, an enzyme that catalyzes the methylation cycle is B12 dependent.[9,10,11]

Folate
Methyl donor for many reactions in the body, including neurotransmitter synthesis and conversion of homocysteine to methionine; Precursor to SAMe; Required for proper DNA synthesis.[12,13,14]

Vitamin B2
Helps recycle folate into a usable methyl-donor form; Precursor to FAD (flavin adenine dinucleotide) which assists methylation reactions.[1,2,3]

Choline
A major source of methyl groups (methyl donor); Deficiency linked to DNA damage.[15,16,17]

Serine
Important methyl donor, especially in the case of folate deficiency.[18,19,20]

Zinc
Deficiency can lower the ability to use methyl groups from methyl donors such as SAMe, thus causing global hypo-methylation of DNA.[32,33,34]

Glutathione
Deficiency impairs methylation reactions and hinders synthesis of the methyl donor SAMe.[21,22]

Vitamin C
Deficiency alters methylation patterns in cancer cells; Also a cofactor for methylating enzymes.[23,24]

Selenium
Inhibits a methylating enzyme (DNA methyltransferase) in cancer genes, effectively turning them off; Selenoproteins protect DNA and metabolize methionine.[30,31]

Magnesium
Its role in the methylation of genes that affect glucose metabolism may explain the link between magnesium deficiency and diabetes.[28,29]

Copper
Several key enzymes needed for methylation reactions are copper dependent.[25,26,27]

PAIN

Cysteine
Reduces pain caused by systemic inflammation due to its potent antioxidant properties.[1,2]

Inositol
In animal studies, treatment with inositol induces antinociception (pain reduction).[3,17]

Oleic Acid
This fatty acid is a precursor of oleamide, an analgesic that affects neurotransmitters such as dopamine, serotonin, acetylcholine and GABA (gamma amino butyric acid), all of which play a role in pain signaling.[4,5]

Antioxidants
Clinical trials show antioxidant therapy is an effective treatment for chronic pain; Vitamin E reduces neuropathic pain; Vitamin C can lower morphine consumption after surgery; Coenzyme Q10 relieves statin-induced myopathy.[28,29,30,31,32]

Carnitine
Deficiency of this amino acid may manifest as muscle weakness, pain (myalgia) or neuropathy. Supplementation reduces several types of chronic pain.[6,7,8]

Lipoic Acid
Very effective treatment for neuropathic pain.[26,27]

Magnesium
Lowers pain by blocking NMDA receptors in spinal cord; Effective in reducing post-operative pain.[9,10,11]

Vitamin D
Deficiency often presents clinically as muscle or bone pain.[23,24,25]

Vitamin B1, B2, B6, B12
These produce a dose dependent decrease in various kinds of pain (heat, pressure, chemical); Increases sensitivity to pain meds; Their effect is likely mediated through serotonergic neurotransmitters.[19,20,21,22]

Choline
Activates specific receptors in brain and spine that lower acute pain.[17,18]

Minerals
is a cofactor for the potent antioxidant superoxide dismutase, which fights free radicals, a known source of pain. **Copper** supplementation can relieve arthritic pain. Treatment with **Selenium** improves muscle pain in deficient patients. Research suggests both **Zinc** and **Calcium** play a role in the transmission of pain signals through nerves.[12,13,14,15,16]

SLEEP APNEA

Antioxidant Status
It is well documented that sleep apnea patients have both reduced antioxidant capacity and higher levels of oxidative stress than controls. [5,6,7,8]

Cysteine
Oral supplementation with cysteine, the precursor to glutathione, has therapeutic potential for sleep apnea. Snore time and duration were significantly reduced for patients treated with N-acetyl cysteine compared to untreated sleep apnea patients. [1,2,3,4]

Vitamin C
Improves endothelial function (blood vessel health) in sleep apnea patients to levels seen in people without sleep apnea. [9,10,11]

Vitamin E
Mitigates the oxidative stress seen in sleep apnea patients; Works synergistically with vitamin C. [5,11,12]

Glutathione
Low levels linked to sleep apnea; This powerful antioxidant helps repair liver damage caused by sleep apnea. [25,26,27]

Vitamin A
Sleep apnea patients have low retinol (vitamin A); Retinol suppresses the growth of vascular smooth muscle, a process that causes blood vessels to clog, linking low vitamin A levels to the cardiovascular complications seen in sleep apnea patients. [13,14]

Minerals
The trace minerals *zinc, copper, magnesium, manganese* and *selenium* are critical cofactors for the major antioxidant enzymes, which are important in repairing cellular damage caused by hypoxia (lack of oxygen) in sleep apnea. [23,24]

Vitamin D
People with sleep apnea have a high prevalence of vitamin D deficiency; The worse the apnea, the more severe the deficiency; Evidence suggests low vitamin D worsens sleep apnea's negative effect on heart disease risk. [15,16,17]

Copper
Considered a strong predictor of oxidative stress in sleep apnea patients; Copper's role as a key cofactor in the powerful antioxidant superoxide dismutase (SOD) explains this; SOD is very low in apnea patients. [21,22]

Selenium
In one case report, selenium supplementation completely stopped snoring caused by non-obesity sleep apnea; Selenium's role as a potent antioxidant may reduce the oxidative stress seen in sleep apnea patients. [18,19,20]

Additional nutrients affect sleep apnea. This list is non-exhaustive.

SPORTS NUTRITION

Carnitine
Allows cells to use fatty acids as an efficient non-glycogen source of fuel; Improves muscle recovery; Offsets the rise in creatine kinase, an indicator of muscle damage. [35,36]

Glutamine
Glutamine depletion compromises immunity in many athletes after intense physical training; Glutamine supplementation by marathoners reduced post-race infections. [1,2,3,4]

Coenzyme Q10
Mitigates muscle damage after high intensity training; Trials indicate CoQ10 benefits both strength and endurance; 300 mg of CoQ10 increased power in Olympic athletes. [5,6,7]

Lipoic Acid
This powerful antioxidant reduces cellular damage due to intense physical exercise; Recycles other antioxidants such as glutathione. [8,9]

Asparagine
Increases the capacity of muscle to use fatty acids and spare glycogen, thus increasing time to physical exhaustion; Intensive training lowers asparagine levels. [32,33,34]

Glutathione
Powerful antioxidant; Detoxifies cellular by-products after workouts; Reduced blood levels of glutathione are counterproductive to an athlete in training. [10,11]

Cysteine
Reduces time to fatigue in endurance sports such as cycling; Precursor to glutathione; Supplementation raises glutathione levels. [12,13,14]

Serine
Keeps an athlete's hormone profile healthy by buffering post-workout cotisol levels, which can cause excess muscle breakdown; May increase aerobic capacity. [29,30,31]

Vitamin C
Decreases post-workout soreness; Required for collagen synthesis and thus protects muscles from injury due to trauma or training; Reduces cortisol induced muscle catabolism. [15,16,17]

Magnesium
Key to the production of ATP (adenosine triphosphate) which is the body's main storage form of energy; Supplementation may improve aerobic performance and muscle strength and repair. [27, 28]

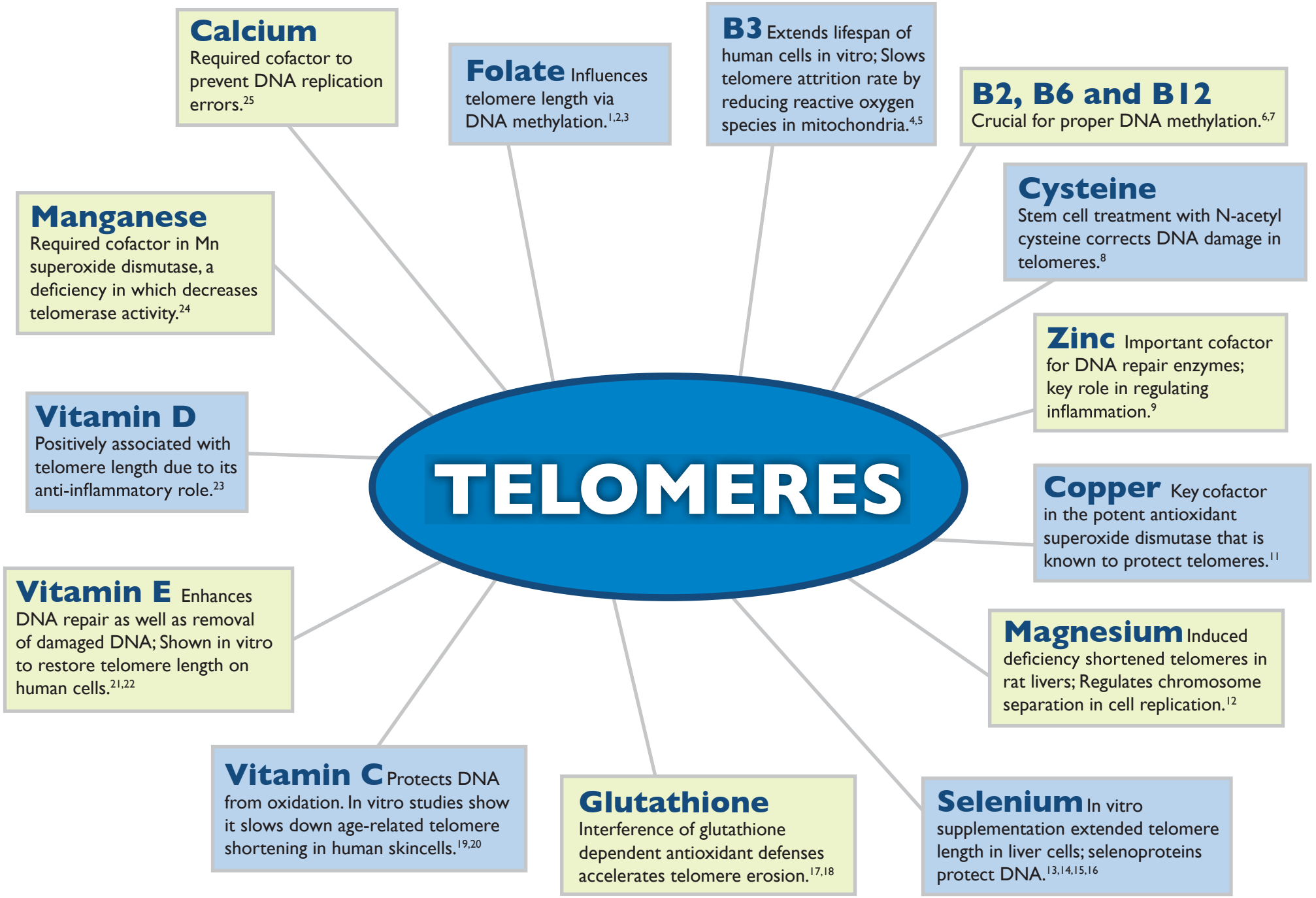
Vitamin E
Intense training causes cellular stress; Vitamin E protects the enzymes responsible for repairing this cellular damage. [18,19]

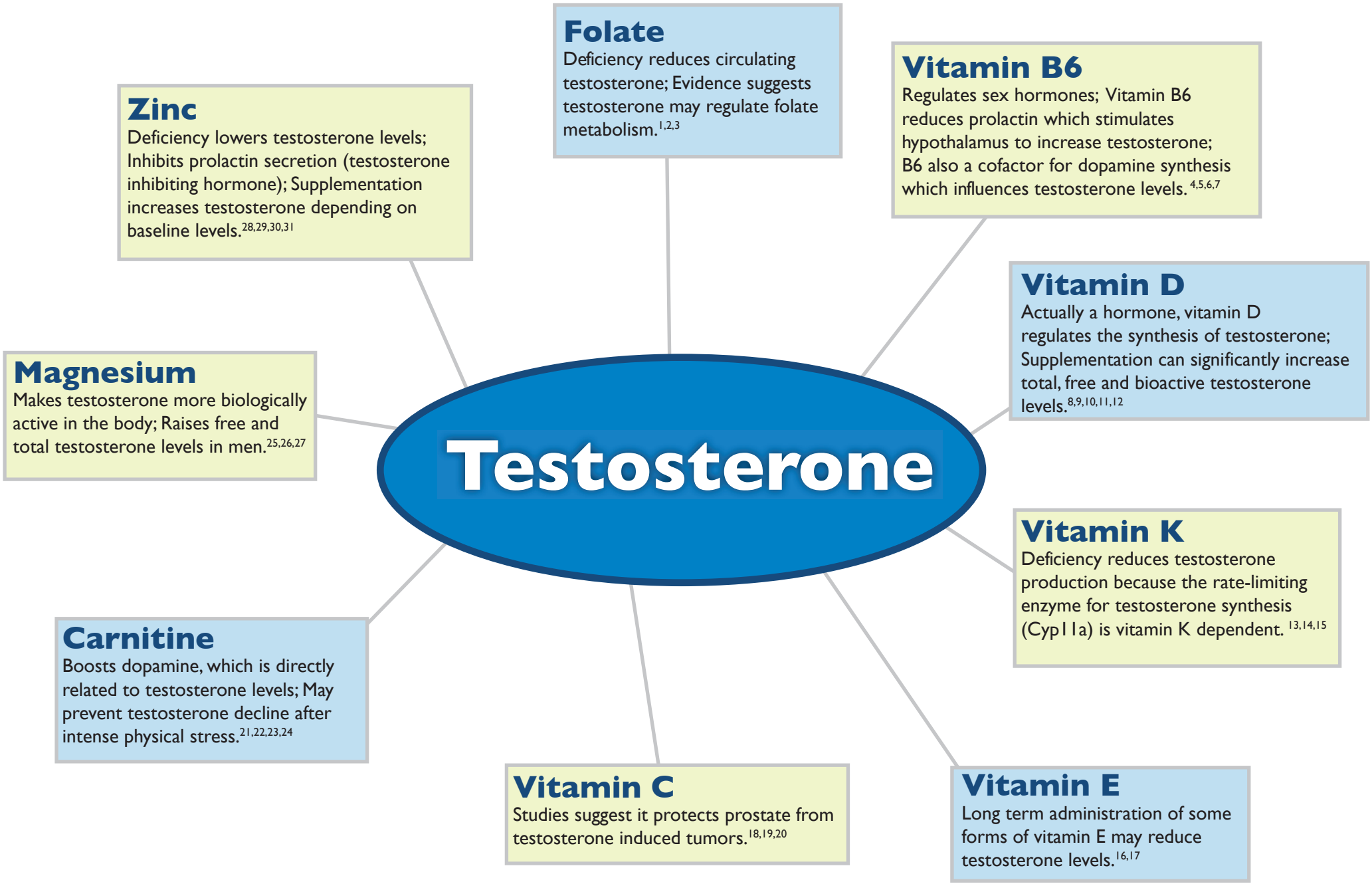
Zinc
Interacts with hormones to improve body composition and strength; Deficiency impairs peak oxygen uptake during exercise; Low zinc common in distance runners & gymnasts; Supplementation should be accompanied by copper. [24,25,26]

B Vitamins
Cofactors for efficient engergy metabolism from food; Synthesizing red blood cells requires B9 (folate) and B12; Deficiencies in various B vitamins may slow healing in sports injuries. [22,23]

Vitamin D
Improves bone strength, thus reducing potential for sports-related injuries and stress fractures. [20,21]

Additional nutrients affect athletic performance. This list is non-exhaustive.





WEIGHT MANAGEMENT

Asparagine
This amino acid increases insulin sensitivity which helps the body store energy in muscle instead of storing it as body fat.[1,2]

Biotin Boosts metabolism by improving glycemic control (stabilizes blood sugar) and lowering insulin, a hormone that promotes fat formation.[3,4,5]

Carnitine
Carries fatty acids into the cell so they can be burned for fuel; Helps reduce visceral adiposity (belly fat). [6,7]

Calcium Inhibits the formation of fat cells; Also helps oxidize (burn) fat cells.[8,9,10]

Zinc Deficiency of zinc reduces leptin, a beneficial hormone that regulates appetite, which is reversed by zinc repletion.[10,37]

Lipoic Acid Improves glucose uptake into cells, which helps a person burn carbohydrates more efficiently.[11,12,13]

Vitamin K
Poor vitamin K status linked to excess fat tissue; Vitamin K helps metabolize sugars.[35,36]

Chromium Makes the body more sensitive to insulin, helping to reduce body fat and increase lean muscle.[14,15,16,27,28,4]

Vitamin D Deficiency strongly linked to poor metabolism of carbohydrates; Genes that are regulated by vitamin D may alter the way fat cells form in some people.[8,33,34]

Vitamin B5 Taking B5 lowers body weight by activating lipoprotein lipase, an enzyme that burns fat cells. One study linked B5 supplementation to less hunger when dieting.[17,18]

Vitamin E Inhibits pre-fat cells from changing into mature fat cells, thus reducing body fat.[10,31,32]

Magnesium Low magnesium in cells impairs a person's ability to use glucose for fuel, instead storing it as fat; Correcting a magnesium deficiency stimulates metabolism by increasing insulin sensitivity. Magnesium may also inhibit fat absorption.[19,20,21]

Vitamin A
Enhances expression of genes that reduce a person's tendency to store food as fat; Reduces the size of fat cells.[10,29,30]

Vitamin B3 (Niacin)
Treatment with B3 increases adiponectin, a weight-loss hormone secreted by fat cells; Niacin-bound chromium supplements helped reduced body weight in clinical trials.[26,27,28]

Inositol
Supplementation may increase adiponectin levels.[25]

Cysteine
Supplementation with this antioxidant reduced body fat in obese patients.[24]

Glutamine
Reduces fat mass by improving glucose uptake into muscle.[22,23]