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

Vitamin E
Deficiency impairs estrogen detoxification pathway; Some forms of vitamin E inhibit estrogen action, especially in breast tissue; Low levels linked to higher estrogen. 1,16,17

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

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

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

Zinc
Estrogen lowers risk of zinc deficiency; Zinc dependent proteins metabolize estrogen. 26,27,28

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

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

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; Detoxifies excess estrogen via methylation pathway. 1,22,23

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

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

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

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

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

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

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

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

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

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

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

serine Counteracts the overproduction of fatigue-causing stress hormones.8,9

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

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

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

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Female Infertility

**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

**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

**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

**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

**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 B₆ & B₁₂**
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

**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

**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

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

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Hypothyroidism negatively affects choline function in the brain, which can affect mood and cognition.\(^{29,30}\)

**Choline**

Decreased tissue levels of carnitine in both hypo- and hyperthyroidism contribute to muscle fatigue.\(^{24,25,26}\)

**Carnitine**

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

**Selenium**

Improves endothelial function in people with subclinical hypothyroidism; Protects thyroid cells from oxidative stress; May interfere with T4 therapy.\(^{27,28}\)

**Lipoic Acid**

This amino acid is part of the structure of thyroid stimulating hormone which regulates communication with other hormones.\(^{22,23}\)

**Asparagine**

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).\(^{3,4,5,6,7}\)

**B Vitamins**

Partially restores thyroid function when liver detoxification ability is compromised.\(^{2,8,9,10,11}\)

**Vitamin C and E**

Activates gene that regulates TSH (thyroid stimulating hormone).\(^{12,13,14}\)

**Vitamin A**

Low levels seen in experimentally induced hypothyroidism; Indirectly affects thyroid status by its antioxidant role via superoxide dismutase.\(^{17}\)

**Zinc**

Increases thyroid hormone T3 in deficient subjects.\(^{15,16,17,20,21}\)

**Copper**

Some antioxidants, such as glutathione peroxidase and superoxide dismutase.\(^{1,2}\)

**Glutathione**

Decreased tissue levels of carnitine in both hypo- and hyperthyroidism contribute to muscle fatigue.\(^{24,25,26}\)

**Carnitine**

Carnitine decreases efficacy of some antioxidants, such as glutathione peroxidase and superoxide dismutase.\(^{1,2}\)

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** WEIGHT MANAGEMENT **

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

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

**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 reduce body weight in clinical trials.26,27,28

**Biotin**
- Boosts metabolism by improving glycemic control (stabilizes blood sugar) and lowering insulin, a hormone that promotes fat formation.34,5

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

**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

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

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

**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

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

**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

**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

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

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