

# FATIGUE

**Carnitine** Transports fatty acids into mitochondria; Decreases both mental and physical fatigue in clinical trials.<sup>15,31,32</sup>

**Chromium** Promotes glucose uptake into cells, helping stabilize blood sugar.<sup>16,33</sup>

**Zinc** Deficiency lowers immunity and may cause muscle fatigue; Involved in several reactions for energy metabolism.<sup>15,34,35</sup>

**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.<sup>1,2,3</sup>

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

**Biotin** Helps liver utilize glycogen for energy. Animal studies confirm that biotin deficiency causes clinical fatigue.<sup>4</sup>

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

**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.<sup>5,6,7</sup>

**Vitamin E** Inverse correlation exists between fatigue and vitamin E levels.<sup>23</sup>

**Serine** Counteracts the overproduction of fatigue-causing stress hormones.<sup>8,9</sup>

**Vitamin A** When cellular levels of vitamin A are low, mitochondrial respiration and ATP production decreases.<sup>22</sup>

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

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

**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,  $\alpha$ -Lipoic acid and Glutathione, of which unusually low levels are seen in chronic fatigue patients.<sup>12,16,18,19,20</sup>

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

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