

Some Biological and Health Effects from Radio Frequency Radiation¹

Exposure Range	Specific Level	Effects Observed
 < 10 $\mu\text{W}/\text{m}^2$	0.001 to 1.0	Changes in genes, problems with chromatin conformation and condensation (DNA) (Belyaev, 1997)
	3.4	Significantly reduced sperm count (Behari, 2006)
	5	Decreased cell proliferation after 30-minute exposure (Velizarov, 1999)
 10 to 99 $\mu\text{W}/\text{m}^2$	6 to 128	Fatigue, depressive tendency, sleeping disorders, concentration difficulties, cardiovascular problems after exposure to whole-body GSM cell phone radio frequency radiation (Oberfeld, 2004)
	30 to 200	Irritation, headaches, concentration difficulties at school in children and adolescents after short-term exposure (Heinrich, 2010)
	30 to 500	Behavioral misconduct at school in children and adolescents after short-term exposure (Thomas, 2010)
	50	Sleep disturbances in some adults after chronic exposure (Mohler, 2010)
	50 to 400	Elevated levels of headache, concentration difficulty in adults (Thomas, 2008)
	60 to 100	Increased production of stress hormones, decreased dopamine, increased adrenaline and nor-adrenaline, and chronic physiological stress in cells after exposure to whole-body radio frequency radiation, with dose-response relationship noted (Buchner, 2012)
 100 to 999 $\mu\text{W}/\text{m}^2$	100 to 500	Headaches, neurological problems, insomnia, difficulty concentrating reported by adults exposed to GSM cell phone radiation (Hutter, 2006; Thomas, 2008)
	100 to 1,100	Fatigue, headaches, insomnia after exposure to radio frequency radiation from cell towers (Navarro, 2003)
	500 to 1,000	Adverse neurological and cardiological symptoms and elevated cancer risk linked to radio frequency radiation (Khurana, 2010)
	500 to 1,000	Headache, concentration and sleeping problems, fatigue related to radio frequency radiation (Kundi, 2009)
	700 to 1,000	Abnormal sperm in mice after six-month exposure to whole-body radio frequency radiation, with dose-dependent results (Otitoloju, 2010)
 $\geq 1,000$ $\mu\text{W}/\text{m}^2$	1,300	Decreased cognition, decreased well-being with exposure to radio frequency radiation from 3G cell towers (Zwamborn, 2003)
	1,600	Impaired motor function, memory, and attention in school children in Latvia (Kolodynski, 1996)
	1,680 to 10,500	Irreversible infertility in mice after five generations of radio frequency radiation (Magras and Zenos, 1997)
	2,000 to 80,000	Increase in childhood leukemia within four kilometers of TV towers (Hocking, 1996)
	2,100 to 12,800	Increases in headaches reported by adolescents and adults exposed to 45 minutes of UMTS cell phone radiation (Riddervold, 2008)
	3,800	Altered calcium metabolism in heart cells (Schwartz, 1990)
	5,000 to 10,000	DNA fragmentation in sperm cells exposed to four hours of WiFi (Avendano, 2012)
	8,000 to 100,000	Free-radical damage to cells, altered emotional behavior (Akoev, 2002)
	10,000	Pathological leakage of the blood-brain barrier (Persson, 1997)
	10,000	Significant effect on immune function in mice (Fesenko, 1999)
	10,000	Altered function of the immune system (Novoselova, 1999)

¹After the RF Color Charts available with the 2012 Bioinitiative Report (www.bioinitiative.org)