

Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure

(Very Low-Intensity RF Exposures Comparable to Cell Towers)

Power Density*	Description	Source
0.0006 - 0.0128 uW/cm ²	Fatigue, depressive tendency, sleeping disorders, concentration difficulties, cardio-vascular problems reported with exposure to GSM 900/1800 MHz cell phone signal at base station level exposures.	Oberfeld, 2004
0.003 - 0.02 uW/cm ²	In children and adolescents (8-17 yrs) short-term exposure caused headache, irritation, concentration difficulties in school.	Heinrich, 2010
0.003 to 0.05 uW/cm ²	In children and adolescents (8-17 yrs) short-term exposure caused conduct problems in school (behavioral problems).	Thomas, 2010
0.005 uW/cm ²	In adults (30-60 yrs) chronic exposure caused sleep disturbances, (but not significantly increased across the entire population).	Mohler, 2010
0.005 - 0.04 uW/cm ²	Adults exposed to short-term cell phone radiation reported headaches, concentration difficulties (differences not significant, but elevated).	Thomas, 2008
0.006 - 0.01 uW/cm ²	Chronic exposure to base station RF (whole-body) in humans showed increased stress hormones; dopamine levels substantially decreased; higher levels of adrenaline and nor-adrenaline; dose-response seen; produced chronic physiological stress in cells even after 1.5 years.	Buchner, 2012
0.01 - 0.11 uW/cm ²	RFR from cell towers caused fatigue, headaches, sleeping problems.	Navarro, 2003
0.01 - 0.05 uW/cm ²	Adults (18-91 yrs) with short-term exposure to GSM cell phone radiation reported headache, neurological problems, sleep and concentration problems.	Hutter, 2006
0.005 - 0.04 uW/cm ²	Adults exposed to short-term cell phone radiation reported headaches, concentration difficulties (differences not significant, but elevated).	Thomas, 2008
0.015 - 0.21 uW/cm ²	Adults exposed to short-term GSM 900 radiation reported changes in mental state (e.g., calmness) but limitations of study on language descriptors prevented refined word choices (stupified, zoned-out).	Augner, 2009
0.05 - 0.1 uW/cm ²	RFR linked to adverse neurological, cardio symptoms and cancer risk.	Khurana, 2010
0.05 - 0.1 uW/cm ²	RFR related to headache, concentration and sleeping problems, fatigue.	Kundi, 2009

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0.07 - 0.1 uW/cm ²	Sperm head abnormalities in mice exposed for 6-months to base station level RF/MW. Sperm head abnormalities occurred in 39% to 46% exposed mice (only 2% in controls) abnormalities was also found to be dose dependent. The implications of the pin-head and banana-shaped sperm head. The occurrence of sperm head observed increase occurrence of sperm head abnormalities on the reproductive health of humans living in close proximity to GSM base stations were discussed."	Otitoloju, 2010
0.38 uW/cm ²	RFR affected calcium metabolism in heart cells.	Schwartz, 1990
0.8 - 10 uW/cm ²	RFR caused emotional behavior changes, free-radical damage by super-weak MWs.	Akoev, 2002
0.13 uW/cm ²	RFR from 3G cell towers decreased cognition, well-being.	Zwamborn, 2003
0.168 - 1.053 uW/cm ²	Irreversible infertility in mice after 5 generations of exposure to RFR from an 'antenna park.'	Magras & Zenos, 1997
0.2 - 8 uW/cm ²	RFR caused a two-fold increase in leukemia in children.	Hocking, 1996
0.2 - 8 uW/cm ²	RFR decreased survival in children with leukemia.	Hocking, 2000
0.21 - 1.28 uW/cm ²	Adolescents and adults exposed only 45 min to UMTS cell phone radiation reported increases in headaches.	Riddervold, 2008
0.5 uW/cm ²	Significant degeneration of seminiferous epithelium in mice at 2.45 GHz, 30-40 min.	Saunders, 1981
0.5 - 1.0 uW/cm ²	Wi-Fi level laptop exposure for 4-hr resulted in decrease in sperm viability, DNA fragmentation with sperm samples placed in petri dishes under a laptop connected via WI-FI to the internet.	Avendano, 2012
1.0 uW/cm ²	RFR induced pathological leakage of the blood-brain barrier.	Persson, 1997
1.0 uW/cm ²	RFR caused significant effect on immune function in mice.	Fesenko, 1999
1.0 uW/cm ²	RFR affected function of the immune system.	Novoselova, 1999
1.0 uW/cm ²	Short-term (50 min) exposure in electrosensitive patients, caused loss of well-being after GSM and especially UMTS cell phone radiation exposure.	Eltiti, 2007
1.3 - 5.7 uW/cm ²	RFR associated with a doubling of leukemia in adults.	Dolk, 1997
1.25 uW/cm ²	RFR exposure affected kidney development in rats (in-utero exposure).	Pyrpasopoulou, 2004
1.5 uW/cm ²	RFR reduced memory function in rats.	Nittby, 2007
2 uW/cm ²	RFR induced double-strand DNA damage in rat brain cells.	Kesari, 2008
2.5 uW/cm ²	RFR affected calcium concentrations in heart muscle cells.	Wolke, 1996

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2 - 4 uW/cm ²	Altered cell membranes; acetylcholine-induced ion channel disruption.	D'Inzeo, 1988
4 uW/cm ²	RFR caused changes in hippocampus (brain memory and learning).	Tattersall, 2001
5 uW/cm ²	RFR caused drop in NK lymphocytes (immune function decreased).	Boscolo, 2001
5.25 uW/cm ²	20 minutes of RFR at cell tower frequencies induced cell stress response.	Kwee, 2001
5 - 10 uW/cm ²	RFR caused impaired nervous system activity.	Dumansky, 1974
6 uW/cm ²	RFR induced DNA damage in cells.	Phillips, 1998
8.75 uW/cm ²	RFR at 900 MHz for 2-12 hours caused DNA breaks in leukemia cells.	Marinelli, 2004
10 uW/cm ²	Changes in behavior (avoidance) after 0.5 hour exposure to pulsed RFR.	Navakatikian, 1994
10 - 100 uW/cm ²	Increased risk in radar operators of cancer; very short latency period; dose response to exposure level of RFR reported.	Richter, 2000
12.5 uW/cm ²	RFR caused calcium efflux in cells - can affect many critical cell functions.	Dutta, 1989
13.5 uW/cm ²	RFR affected human lymphocytes - induced stress response in cells.	Sarimov, 2004
20 uW/cm ²	Increase in serum cortisol (a stress hormone).	Mann, 1998
28.2 uW/cm ²	RFR increased free radical production in rat cells.	Yurekli, 2006
37.5 uW/cm ²	Immune system effects - elevation of PFC count (antibody producing cells).	Veyret, 1991
45 uW/cm ²	Pulsed RFR affected serum testosterone levels in mice.	Forgacs, 2006
50 uW/cm ²	Cell phone RFR caused a pathological leakage of the blood-brain barrier in 1 hour.	Salford, 2003
50 uW/cm ²	An 18% reduction in REM sleep (important to memory and learning functions).	Mann, 1996

***Power Density (Microwatts/centimeter² - uW/cm²)**

Color Key and Notes on page 4.

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Color Key

Stress proteins, HSP, disrupted immune function

Reproduction, fertility effects

Sleep, neuron firing rate, EEG, memory, learning, behavior

Oxidative damage, reactive oxygen species, DNA damage, DNA repair failure

Blood-brain barrier leakage

Cardiac, heart muscle, blood pressure, vascular effects

Notes

RF Levels exceed 0.1 to 0.5 $\mu\text{W}/\text{cm}^2$ in nearly all locations of fire stations (at ground level)
(LTE antennas only on a 70' pole)

RF levels exceed 15 to 17 $\mu\text{W}/\text{cm}^2$ at 40' to 50' distance from tower (at ground level):
no levels are less than 3 $\mu\text{W}/\text{cm}^2$ out to 200' away from cell tower (at ground level)
(with co-location of two additional carriers on a 70' monopole).

Home 40' away and 50' higher (uphill): 2.60 $\mu\text{W}/\text{cm}^2$ (Table 8)

Home 50' away and 50' higher (uphill): 6.98 $\mu\text{W}/\text{cm}^2$ (Table 8)

(LTE antennas only on a 70' monopole)

Home 40' away and 50' higher (uphill): 256 $\mu\text{W}/\text{cm}^2$ (Table 24)

Home 50' away and 50' higher (uphill): 303 $\mu\text{W}/\text{cm}^2$ (Table 24)

(with co-location of two additional carriers on a 70' monopole).