(8/30/2020)

Table 1. RFR studies that used the Comet assay. (*no effect observed) ; umber of papers that showed effect = 78 (65%); no effect = 47 (35%)

	Exposure conditions	Results
*Akdag et al. (2016)	Male Wistar-Albino rats to 2400 MHz RFR from a Wi-Fi signal generator for a year; SAR 0.000141 (min)- 0.007127 (max) W/kg	No significant change in DNA single strand breaks (Comet assay) in brain, kidney, liver, and skin tissues, increased in testes.
Akdag et al. (2018)	Men who used cell phone for different durations per day; peak head SAR 0.45-0.79 W/kg	Increased DNA single strand breaks (Comet assay) in ear canal hair follicle cells; a dose-response relationship was observed.
Alkis et al. (2019a)	Rats exposed to 900 MHz (brain SAR 0.0845 W/kg), 1800 MHz (0.04563 W/kg), and 2100 MHz (0.03957 W/kg) RFR 2 h/day for 6 months	Increased DNA single strand break (Comet assay), oxidative DNA damage, and oxidative stress in brain frontal lobe.
Alkis et al. (2019b)	Rats exposed to 900 MHz, 1800 MHz, and 2100 MHz RFR 2 h/day for 6 months; maximum SAR over the rat 0.017 W/kg	Increased DNA single strand beak (Comet assay), oxidative DNA damage and oxidative stress in testicular tissue.
Al-Serori et al. (2018)	Ten human cell types exposed to intermittent (5 mi ON/10 min OF) UMTS 1750 MHz signal for 16 h, SAR 0.25, 0.5,	Increased in DNA single strand breaks (Comet assay) in U87 p52- proficient glioblastoma cells grew under serum free condition; no effect on double strand breaks (γH2AX foci); nucleotide excision repair

	and 1 W/kg	induced.
Baohong et al. (2005)	Human lymphocytes exposed in vitro to 1800 MHz RFR (SAR 3 W/kg) for two hours and also co-treated with various mutagens	DNA strand break assayed (Comet assay) at 0 and 21 h after treatment. No effect when cells were exposed to RFR alone. But, RFR co-exposure enhanced the DMA damage induced by mitomycin C and 4-nitroquinoline-1-oxide.
Baohong et al. (2007)	Human lymphocytes exposed in vitro to 1800 MHz RFR (SAR 3 W/kg) for 0. 1.5, and 4 h. Cells were also co-treated with ultraviolet ray C	DNA damage as assayed by the Comet assay showed no significant effect with RFR alone. But, RFR co-exposure reduced DNA damage induced by ultraviolet C.
Bektas et al (2020)	Pregnant women who used cell phone and Wi-Fi; placenta nd cord blood samples were analyzed	Samples from cell phone users showed increased oxidative DNA damage and oxidative stress; Wi-Fi users showed increased oxidative DNA damage but no oxidative stress; more DNA single strand breaks (Comet assay) in cell phone users than in control (did not use cell phone nor Wi-FI) and Wi-Fi users; Wi-Fi and cell phone uses were synergistic.
Cam and Seyhan (2012)	Hair root cells of human subjects after 15-30 min use of a 900-MHz GSM cell phone	Increased in DNA single strand breaks (Comet assay) was observed; more damages resulted after 30 min than after 15 min use.
Chandel et al. (2019a)	Onion roots (Allium cepa L.) were exposed to 2350 MHz RFR for 1, 2, or 4 h, SAR 0.313 W/kg	Increased in mitotic index and chromosomal aberration; significant increase in DNA single strand break (Comet assay) at 2 and 4 h.
Chandel et al. (2019b)	Onion roots (Allium cepa L.) were exposed to 2100 MHz RFR for 1 or 4 h, SAR 0.282 W/kg	Increased mitotic index, chromosomal aberration, and DNA single-strand breaks (Comet assay) after 4 h of exposure.

Chaturvedi et al. (2011)	Male mice exposed to 2450 MHz RFR, 2 h/day for 30 days; SAR 0.03561 W/kg	Increased DNA single strand breaks (Comet assay) in brain cells.
*Chemeris et al. (2004)	Frog (Xenopus laevis) erythrocytes exposed to high peak power pulsed RFR (8.8 GHz, 180 ns pulse width, peak power 65 kW, repetition rate 50 Hz) for 40 min;SAR 1.6 kW/kg (peak SAR 300 MW/kg)	Increased DNA single strand breaks (Comet assay) was caused by temperature rise.
*Chemeris et al. (2006)	Human whole blood leukocytes and isolated lymphocytes exposed to pulsed 8.8 Hz RFR (180 ns pulse width, peak power 65 kW, pulse repetition frequency 50 Hz) for 40 min: average SAR 1.6 kW/kg (peak 300 mW/kg)	No change in DNA single strand breaks (Comet assay)
d'Ambrosio et al. (1995)	Huamn blood exposed to 9 GHz RFR (continuous-wave or 50-Hz amplitude modulated) for 10 min; SAR 90 W/kg	Increased in micronucleus frequency in lymphocytes after exposure to the amplitude modulated RFR.
d'Ambrosio et al. (2002)	Human blood cultures exposed to 1748 MHz RFR (continuous –wave or phase modulated (GMSK)) for 15 min: SAR ~5 W/kg	Micronucleus frequency in lymphocytes was increased only after exposure to phase-modulated RFR.
Danese et al. (2017)	Human whole blood exposed to 900 MHz RFR from a cell phone	No change in frewuency of γ-H2AX foci (double strand DNA breaks) in lymphocytes.

	for 30 min	
De Amicis et al. (2015)	Human foetal fibroblasts exposed to THz radiation (0.1-0.15 THz) for 20 min; SAR 15-20 W/kg	Increased total number of micronuclei and centromere positive micronuclei that could lead to chromosome loss. No significant effect on DNA strand breaks (Comet assay), phosphorylation of H2AX histone and apoptosis.
Deshmukh et al. (2013)	Male Fischer rats exposed to 900 MHz (0.0005953 W/kg), 1800 MHz (0.0005835 W/kg), and 2450 MHz (0.0006672 W/kg) RFR for 2 h/day, 5 days/week for 30 days.	Increased DNA single strand breaks (Comet assay) in brain tissues.
Deshmukh et al. (2015)	Male Fischer rats exposed to 900 MHz (0.0005953 W/kg), 1800 MHz (0.0005835 W/kg), and 2450 MHz (0.0006672 W/kg) RFR for 2 h/day, 5 days/week for 180 days.	Increased DNA single strand breaks (Comet assay) in brain tissues; elevated heat-shock protein-70 level.
Deshmukh et al. (2016)	Male Fischer rats exposed to 900 MHz (0.0005953 W/kg), 1800 MHz (0.0005835 W/kg), and 2450 MHz (0.0006672 W/kg) RFR for 2 h/day, 5 days/week for 90 days.	Increased DNA single strand breaks (Comet assay) in brain tissues; elevated heat-shock protein-70 level.
Diem et al.(2005)	Human diploid fibroblasts and cultured rat granulosa cells exposed to 1800 MHz intermitten (5 min On/10 min Off) or	Increased in DNA single and double strand breaks (Comet assay) in both cell types after 16 h exposure. Intermittent wave showed a higher effect than continuous wave.

	continuous –wave; SAR 1.2 or 2 W/kg	
Duan et al (2015)	Mouse spermatocyte-derived GC-2 cells exposed to intermittent (5 min On/10 min Off) 1800 MHz RFR (from a GSM cell phone in talk mode) for 24 h; SAR 1. 2 , or 4 W/kg	Increased oxidative DNA damage a 4 W/kg; no significant effect with Comet assay.
*Durdik et al. (2019)	Umbilical cord blood (UCB) cells exposed to a GSM900 (1-17 h, 0.004 or 0.04 W/kg) or UMTS-1947.4 MHz (3 h, 0.04 /kg) cell phone signals fed to a TEM cell	No changes in DNA single and double strand breaks (Comet assay), and apoptosis; increased reactive oxygen species was observed.
Franchini et al. (2018a)	Human fetal and adult fibroblasts exposed to 25 GHz RFR for 20 min; SAR 20W/kg	Increased total number of micronuclei and centromere positive micronuclei in exposed samples. No significant effect on DNA single strand break (Comet assay).
Franzellitti et al. (2010)	Human trophoblast HTR-8/SVneo cells exposed to1800 MHz continuous –wave. GSM (217 Hz modulated) and GSM intermittent (5 min on/10 min off) RFR for 4. 16, or 24 h: SAR 2 W/kg	GSM signals increased DNA single strand breaks (Comet assay) after 16 and 24 h exposure; recovered within 2 h post-exposure; continuous-wave RFR was without effect.
Furtado-Filho et al. (2014)	Rats of different ages (0-30 days) exposed 950 MHz RFR for 0.5 h/day for 51 days (21 days of gestation and 6-30 days old): SAR pregnant rat 0.01-0.03 W/kg; neonate	Decreased DNA single strand breaks (Comet assay) in liver of 15-day old and increased breaks in 30-day old rats, no oxidative stress detected.

	0.88 W/kg, 6-day old 0.51 W/kg, 15-day old 0.18 W/kg, 30-day old 0.06 W/kg.	
*Furtado-Filho et al. (2015)	At exposed to 950 MHz RFR. 0.5 h/day to 27 days (throughout pregnancy and 6 days postnatal); SAR 0.44-0.35 W/kg, neonatal rat 1.32 W/kg, 6-day old 1.14 W/kg	Right cerebral cortex showed an increase in DNA single strand breaks (Comet assay), but no significant effect in the left cerebral cortex in RFR-exposed 6-day old rats. No oxidative effects observed.
Gajski and Garaj-Vrhovac (2009)	Blood samples from Wistar rats exposed to GSM-modulated 915 MHz RFR for 30 min, SAR 0.6 W/kg	Increased basal (single strand) and oxidative DNA damage (Comet assay) in lymphocytes.
Gandhi and Anita (2005)	Blood from cell phone users (most for 2-5 yrs)	Increased DNA single strand breaks (Comet assay) and micronucleus found in cell phone users.
Gandhi et al. (2015)	People lived within 300 m of a cell phone base station (average power density= 1.149 mW/cm^2) for an average of 7.45 yrs, controls average power density = 0.0045 mW/cm^2.	Increased DNA single strand breaks (Comet assay) in peripheral blood leukocytes. Daily cell phone usage, location of residence, and power density are significant predictor of DNA damage.
Gapeyev et al. (2014)	Mouse blood samples exposed to 1-Hz pulse-modulated 42.2 GHz RFR for 20 min, SAR 1.5 W/kg; and x-rays	Pre-exposure to pulse-modulated RFR (not continuous-wave) reduced x-ray-induced DNA single strand breaks (Comet assay) in lymphocytes Effect may be related induction of reactive oxygen species by RFR.
Garaj-Vrhovac and Orescanin (2009)	Peripheral blood lymphocytes of workers on radar equipment and	Increased DNA single strand breaks (Comet assay) and bleomycin-induced chromatid breakage.

	antenna system service, 1250-1350 MHz; power density 10 μW/cm^2 -20 mW/cm^2; average employment duration 13.3 yrs	
Garaj-Vrhovac et al. (2009)	Wistar rats exposed to 915 MHz RFR 1 h/day for two weeks, SAR 0.6 W/kg	Increased basal DNA single strand break and oxidative DNA damages (Comet assay) in blood lymphocytes.
Garaj-Vrhovac et al. (2011)	Workers occupationally exposed to marine radar pulsed RFR (3, 5.5, and 9.4 GHz)	Increased DNA single strand break (Comet assay) and micronucleus in blood lymphocytes; increased oxidative stress.
*Glaser et al. (2016)	Human hematopoietic stem cells and leukemia HL-60 cells exposed to GSM (900 MHz), UMTS (1,950 MHz) and LTE (2,535 MHz) for 4, 20 or 66 h:SAR 0-4 W/kg	No effect on apoptosis, oxidative stress, cell cycle, DNA damage (DNA single strand breaks (Comet assay)) and DNA repair. A significant decrease in DNA breaks was found in hematopoietic stem cells exposed for 4 h to GSM signal.
Gulati et al. (2016)	Blood and buccal cells of people lived close (<400 meters) to a cell tower; 1800 MHz, Maximum power density (at 150 meters) 1.22 μW/cm^2, some subjects lived in the area for more than 9 yrs	Inceased DNA single strand breaks (Comet assay) in lymphocytes and micronucleus in buccal cells. Female subjects had significantly higher effects than males.
He et al. (2017)	Mouse bone marrow stromal cells exposed to a 900 MHz RFR 3 h/day for 5 days; peak and average SAR 4.1 x 10^{-4} and 2.5 x 10^{-4} W/kg, some cells were	Induced PARP-1. Cells exposed to RFR and gamma ray showed significantly decreased genetic damage (DNA single strand break (Comet assay)) as well as faster kinetics of repair compared with those exposed to GR alone.

	challenged with one dose of gamma ray.	
*Hintzsche et al. (2012b)	Human keratinocytes (HaCaT) and human dermal fibroblasts (HDF) exposed to 0.106 THz (106 GHz) RFR for 2, 8, 24 h; 0.88 -2 mw/cm^2 (2mw/cm^2 gave a SAR of 13.34 W/kg)	No effect on micronucleus frequency and DNA single strand breaks (Comet assay).
*Hook et al. (2004) (Roti-Roti)	Human Molt-4 T lymphoblastoid cells exposed to 847.74 MHz code-division multiple-access (CDMA) (SAR 3.2 W/kg), 835.62 MHz frequency-division multiple-access (FDMA) (3.2 W/kg), 813.56 MHz iDEN(R) (iDEN) (0.0024 or 0.024 W/KG), and 836.55 MHz time-division multiple-access (TDMA) (0.0026 or 0.026 W/kg) for up to 24 h	No significant changes in DNA single strand breaks (Comet assay) and apoptosis.
Houston et al. (2019)	Male mice exposed to 906 MHz RFR for 12 h/day for 1, 3,or 5 weeks; SAR 2.2 W/kg	Increased DNA oxidative and fragmentation (Comet assay) in spermatozoa across all exposure periods, increased mitochondrial reactive oxygen species.
*Huang et al. (2008a)	Jurkat human T lymphoma cells exposed for 24 h to 1763 MHz RFR; SAR 10 W/kg	Alterations in cell proliferation, cell cycle progression, DNA integrity (Comet assay) or global gene expression were not detected.
*Huang et al. (2008b)	HEI-OC1 immortalized mouse auditory hair cells exposed to 1763 MHz	No significant effects on cycle distribution, DNA damage (Comet assay), stress response and gene expression

	(CDMA) RFR for 24 or 48 h; SAR 20 W/kg	
Ji et al (2004)	Human subjects used cell phones for 4 h.	DNA single strand breaks (Comet assay) increased in peripheral blood cells (T-cells, B-cells, granulocytes).
Ji et al. (2016)	Mouse bone-marrow stromal cells (BMSC) exposed to 900-MHz RFR for 4 h/day for 5 days; power density 0.12 mW/cm^2; some cells were also irradiated with 1.5 Gy γ-radiation after RFR exposure	RFR followed by γ-radiation exposure significantly decreased number of DNA strand breaks (Comet assay) and resulted in faster kinetics of repair of DNA strand breaks compared to γ-radiation alone. Thus, data suggest that RFR preexposure protected cells from damage induced by γ-radiation.
Jiang et al. (2012)	Mice were pre-exposed to a 900-MHz RFR for 4 h/day for 1, 3, 5, 7, and 14 days; power density 0.12 mW/cm2 and then subjected to an acute dose of 3 Gy γ-radiation	DNA single strand breaks (Comet assay) in blood leukocytes from mice pre-exposed to RFR for 3, 5, 7, and 14 days showed progressively decreased damage and was significantly different from those exposed to γ-radiation alone.
Kesari and Behari (2009)	Male Wistar rats exposed to 50-GHz RFR 2 h/day for 45 days; SAR 0.0008 W/kg	Increased in brain tissue DNA double strand breaks (Comet assay); decreased antioxidant enzymes superoxides dismutase and glutathione peroxidase, and increased catalase activity.
Kesari et al. (2010)	Male Wistar rats exposed to 2.45-GHz RFR 2 h/day for 35 days; SAR 0.11 W/kg	Increased in brain tissue DNA double strand breaks (Comet assay); decreased antioxidant enzymes superoxides dismutase and glutathione peroxidase, and increased catalase activity.
Kesari et al. (2014)	Male Wistar rats exposed to a 3D cell phone. 2h/day for 60 days; SAR 0.26 W/kg	Increased DNA double strand breaks (comet assay), micronuclei, Caspase 3 and apoptosis in brain cells; activation of hsp27/p38MAPK stress pathway.

Kim et al. (2008)	Mouse lymphoma cells and Chinese hamster lung cells exposed to 835-MHz RFR for 48 h; SAR 4W/kg	RFR increased clastogens-induced DNA single strand breaks (Comet assay).
*Koyama et al. (2016b)	Human corneal epithelial (HCE-T) and human lens epithelial (SRA01/04) cells exposed to 60 gigahertz (GHz) RFR for 24 h; 1 mW/cm2	No effect on micronucleus formation DNA single strand breaks (Comet assay) and heat shock protein expression.
Kumar A. et al. (2020)	Allim cepa (onion) root meristematic cells exposed to 900- (0.0902 W/kg) and 1800-MHz (0.169 W/kg) RFR for 0.5, 1, 2, and 4 h	Increased chromosomal aberrations and increased DNA single strand breaks (Comet assay).
*Kumar G. et al. (2011) (Andrew Wood)	Long bone (femur and tibia) of male Sprague – Dawley rats exposed to 900-MHz continuous-wave RFR for 30 min; SAR 2 W/kg	No significant effect on DNA single-strand breaks (Comet assay) in bone marrow lymhpocytes.(Assayed at 72 h after exposure.)
*Kumar G. et al. (2015) (Andrew Wood)	Long bone (femur and tibia) of male Sprague – Dawley rats exposed to 900 and 1800 MHz continuous-wave and pulsed RFR; 900-MHz CW at 2 and 10 W/kg for 90 min and 1800-MHz CW and PW at 2.5 and 12.4 W/kg for 120 min	No significant effect on DNA single-strand breaks (Comet assay) in bone marrow lymphoblasts. (Assayed at 1 h after exposure.)
Kumar S. et al. (2013)	Male Wistar rats exposed to a 10 GHz RFR 2h/day for 45 days; SAR 0.014	Increased micronucleus frequency in blood lymphocytes and increased single strand breaks (Comet assay) in spermatozoa.

	W/kg	Decreased testosterone and testicular size.
Kumar S. et al. (2014)	Male Wistar rats exposed to 1910.6 MHz RFR from a cell phone in "talk mode' for 60 days (2 h/day, 6 days a week); SAR 0.28 (Max.) and 0.0226 (Min.)	Increased DNA single strand breaks (Comet assay) an lipid peroxidation in spermatozoa,
*Lagroye et al. (2004a) (Roti-Roti)	Sprague-Dawley rats exposed to pulsed 2450-MHz RFR for 2 h; SAR 1.2 W/kg	No significant change in DNA single strand breaks (Comet assay) (with or without proteinase-k treatment of samples-for detection of DNA-protein crosslinks) in brain cells.
*Lagroye et al. (2004b) (Roti-Roti)	Clonal mouse embryo C3H 10T(1/2) cells exposed 2450-MHz continuous-wave RFR for 2 h; SAR 1.9 W/kg	No significant change in DNA single strand breaks (Comet assay) (with or without proteinase-k treatment of samples.)
Lai and Singh (1995)	Male Sprague-Dawley rats exposed to pulsed or continuous-wave 2450-MHz RFR for 2 h; SAR 0.6 and 1.2 W/kg	Increased DNA single strand breaks (Comet assay) in brain cells was observed at 4 h after exposure to pulsed RFR and at 0 and 4 h after continuous-wave exposure.
Lai and Singh (1996)	Male Sprague-Dawley rats exposed to pulsed or continuous-wave 2450-MHz RFR for 2 h; SAR 1.2 W/kg	Increased DNA single- and double-strand breaks (Comet assay) in brain cells was observed at 4 h after exposure to pulsed or continuous-wave RFR.
Lai and Singh (1997)	Male Sprague-Dawley rats exposed to pulsed 2450-MHz RFR for 2 h; SAR 1.2 W/kg	Increased DNA single- and double-strand breaks (Comet assay) in brain cells at 4 h after exposure. Effects blocked by melatonin or the spin-trap compound N-tert-butyl-alpha-phenylnitrone. (Free radicals are involved in the effects).
Lai and Singh (2005)	Male Sprague-Dawley	Increased DNA single- and double-strand

	rats exposed to continuous-wave 2450-MHz RFR for 2 h; SAR 0.6 W/kg	breaks (Comet assay) in brain cells at 4 h after exposure. Effects blocked by a temporally incoherent magnetic field.
Lai et al. (1997)	Male Sprague-Dawley rats exposed to pulsed 2450-MHz RFR for 2 h; SAR 1.2 W/kg	Increased DNA double-strand breaks (Comet assay) in brain cells at 4 h after exposure. Effect blocked by naltrexone. (Involvement of endogenous opioids in the effects).
Lakshmi et al. (2010)	Human subjects professionally using VDTs	No effect on DNA single strand break (comet assay) and micronucleus frequency in blood cells of subjects exposed for 2 years; increased in long-term (>10 years) users.
*Li et al. (2001) (Roti-Roti)	Murine C3H 10T(1/2) fibroblasts exposed to 847.74 MHz code-division multiple access (CDMA) and 835.62 frequency-division multiple access (FDMA) RFR for 2, 4, or 24 h; SAR 3.2 - 5.1 W/kg	No significant effect on DNA single strand breaks (Comet assay).
Li et al. (2018)	Mouse spermatocyte-derived cells (GC-2) were exposed to 1800-MHz RFR for 24 h, SAR 1, 2 or 4 W/kg	No effect on DNA double strand streak, increased DNA simgle strand breaks (Comet assay); free radicals involved.
Liu et al. (2013a)	Mouse spermatocyte-derived GC-2 cell line exposed to 1800-MHz Global System for Mobile Communication (GSM) signals (5 min on and 10 min off) for 24 h; SAR 1, 2, or 4 W/kg	Increased DNA single strand breaks (comet assay) and DNA adduct 8-oxoguanine at SAR of 4 W/kg; increased reactive oxygen species generation.
Liu et al. (2013b)	Mouse spermatocyte-derived GC-2 cell line was	Increased DNA single strand breaks (Comet

	exposed to a commercial mobile phone handset once every 20 minutes in standby, listen, dialed or dialing modes for 24 h; power density 0.0059-0.0122 mW/cm^2	assay) (attenuated by melatonin).
Luukkonen et al. (2009)	Human SH-SY5Y neuroblastoma cells exposed to 872-MHz (CW and GSM) RFR for 1 h; SAR 5 W/kg	CW RFR increased DNA single strand breaks (Comet assay) and reactive oxygen species in cells treated with menadione (a chemical that induces intracellular ROS production and DNA damage) compared to cells treated with menadione alone. GSM-modulated RFR had no significant effect.
*Luukkonen et al. (2010)	Human SH-SY5Y neuroblastoma cells exposed to 872-MHz (CW and GSM) RFR for 3 h (DNA damage) and 1 h (reactive oxygen species) ; SAR 5 W/kg	CW and modulated RFR had no significant effect on DNA single strand breaks (Comet assay) and reactive oxygen species production in cells treated with ferrous chloride,
*Maes et al. (1997)	Human whole blood cells exposed to 935.2 MHz RFR alone and in combination with mitomycin C for 2 h; SAR 0.3-0.4 W/kg	No significant effects of RFR on chromosome aberration, sister chromatid exchange, and DNA single strand breaks (comet assay). No synergistic effect with mitomycin C.
*Maes et al (2006)	Peripheral blood lymphocytes from subjects who were professionally exposed to cell phone RFR	No evidence of RFR-induced genetic effects: DNA single strand breaks (Comet assay), chromosome aberration, and sister chromatid exchange.
*Malyapa et al. (1997a)	U87MG and C3H 10T1/2 cells exposed to 2450-MHz continuous-wave RFR for 2 h; SAR 0.7 and	No significant effects on DNA single strand breaks (Comet assay).

	1.9 W/kg	
*Malyapa et al. (1997b)	Mouse C3H 10T1/2 fibroblasts and human glioblastoma U87MG cells exposed to 835.62 MHz (FMCW) and 847.74 MHz (CDMA) RFR up to 24 h; SAR 0.6 W/kg	No significant effects on DNA single strand breaks (Comet assay).
*Malyapa et al. (1998)	Male Sprague-Dawley rats exposed to 2450 MHz continuous-wave (CW) RFR for 2 h; SAR 1.2 W/kg	No significant effects on DNA single strand breaks (Comet assay) in cerebral cortex or hippocampus.
*McNamee et al. (2002a)	Human blood cultures exposed to continuous-wave 1900 MHz RFR for 2 h; SAR 0-10 W/kg	No effect on DNA single strand breaks (Comet assay) in leukocytes.
*McNamee et al. (2002b)	Human blood cultures exposed to pulsed 1900 MHz RFR for 2 h; SAR 0-10 W/kg	No effect on DNA single strand breaks (Comet assay) and micronucleus formation in leukocytes.
*McNamee et al. (2003)	Human blood cultures exposed to continuous-wave or pulsed 1900 MHz RFR for 24 h; SAR 0-10 W/kg	No effect on DNA single strand breaks (Comet assay) and micronucleus formation in leukocytes.
Meena et al. (2014)	Wistar rats exposed to 2.45 MHz RFR 2 h/day for 45 days; SAR 0.14 W/kg. Rats also treated with melatonin.	Increased in DNA single strand breaks (Comet assay) and oxidative stress in testicular tissue. Effects attenuated by melatonin.
Megha et al. (2015b)	Fischer rats exposed to 900, 1800, and 2450 MHz RFR for 60 days (2 h/day, 5 days/week);	Increased DNA single-strand breaks (Comet assay) in hippocampus, increased oxidative stress and pro-inflammatory cytokines (IL-2, IL-6, TNF-α, and IFN-γ)

	SAR 0.00059, 0.00058, and 0.00066 W/kg	
*Miyakoshi et al. (2002)	Human brain tumor derived M)54 cells exposed to 2450 MHz RFR for 2 h; SAR 50 or 100 W/kg	No effect on DNA single strand breaks (Comet assay) observed.
*Mizuno et al. (2015)	WI38VA13 subcloned 2RA human fibroblast cells exposed to wireless power transfer (WPT) 12.5 MHz resonanct frequency for 48, 96, or 144 h; SAR 21 W/kg	No effects on cell growth, cell cycle distribution, DNA single strand breaks (Comet assay), micronucleus formation, and hypoxanthine-guanine phosphoribosyltransferase (HPRT) gene mutation.
Pandey et al. (2017)	Swiss albino mice exposed to 900-MHz RFR for 4 or 8 h per day for 35 days; SAR 0.0054-0.0516 W/kg	RFR exposure-induced oxidative stress causes DNA single-strand breaks (Comet assay) in germ cells, with altered cell cycle progression leading to low sperm count in mice (depolarization of mitochondrial membranes resulting in destabilized cellular redox homeostasis). Larger effect with longer exposure time, and recovery at 35 days post-exposure.
Paulraj and Behari (2006)	35-day old male Wistar rats exposed 2 h/day for 35 days to 2450 MHz or 16.6 GHz RFR; SAR 1.0 and 2.01 W/kg, respectively.	Increased in DNA single strand breaks (Comet assay) in brain cells for both frequencies.
Phillips et al. (1998)	Human Molt-4 T-lymphoblastoid cells exposed to pulsed signals at cellular telephone frequencies of 813.5625 MHz (iDEN signal) and 836.55 MHz	Changes in DNA single strand breaks (increase and decrease depending on exposure parameters) (Comet assay) were observed.

	(TDMA signal) for 2or 21 h. SAR 0.0024 and 0.024 W/Kg for iDEN and 0.0026 and 0.026 W/kg for TDMA)	
*Sakuma et al. (2006)	Human glioblastoma A172 cells exposed to W-CDMA 2.1426 GHz radiation at SARs of 80, 250, and 800 mW/kg and CW radiation at 0.08 W/kg for 2 and 24 h; normal human IMR-90 fibroblasts from fetal lungs exposed to W-CDMA and CW radiations at a SAR of 0.08 W/kg for 2 and 24 h.	No significant effect on DNA single strand breaks (Comet assay).
*Sannino et al. (2006)	Human blood leukocytes exposed to UMTS-1950 MHz signal for 24 h; SAR 0.5 or 2 W/kg	No effect on DNA single strand breaks (Comet assay) and cell viability.
*Sannino et al. (2009a)	Human dermal fibroblasts from a healthy subject and from a subject affected by Turner's syndrome exposed to GSM 900 MHz.RFR for 24 h; SAR 1 W/kg	No significant effect on DNA single strand breaks (Comet assay)
*Sannino et al. (2009b)	Human dermal fibroblasts from one subject exposed to 900 MHz RFR for 24 h; SAR 1 W/kg	No significant effect on DNA single strand breaks (Comet assay) and micronucleus frequency.

* Schuermann et al. (2020)	Human MRC-5 lung fibroblasts, human osteosarcoma cells, HTR-8/SVneo human trophoblasts, and GFP-tagged XRcc1 cells exposed to intermittent (5/10 min ON/FF) or continuous 1950 MHz, 2450 MHz (GSM or unmodulated) RFR for 1-24 h; SAR 0.5-4.9 W/kg.	No significant effect on DNA single strand breaks (Comet assay).
Schwarz et al. (2008)	Human fibroblasts and lymphocytes exposed to UMTS 1950 MHz RFR for 4-48 h; SAR 0.05 to 2.- W/kg	Increased DNA single strand breaks (comet assay) and micronuleus were observed in fibroblasts but not in lymphocytes either unstimulated or stimulated with phytohemegglutinin.
*Senturk et al. (2019)	Lymphocytes from patients received radiofrequency treatment on inferior turbinate as they were diagnosed with inferior turbinate hypertrophy	No significant effect on DNA single strand breaks (Comet assay) on Day 15 post-treatment. Increase in oxidative stress was observed.
Shahin et al. (2013)	Female mice (Mus musculus) exposed to continuous-wave 2.45 GHz RFR 2 h/day for 45v days; SAR 0.023 W/kg	Increased DNA strand breaks (Comet assay) observed in the brain. Changes in oxidative mechanisms and oxidative stress were observed in liver, kidney and ovary. Increased embryo implantation/resorption and abnormal pregnancy were observed.
Shahin et al. (2019)	Male Wistar rats exposed to 900 MHz RFR for 2 h/day for 8 weeks, SAR 1.075 W/kg	Increased DNA single strand breaks (Comet assay) in testis and increased oxidative stress.
Sharma ad Shukla (2020)	Male Wistar rats exposed to 900 MHz RFR for 1,	Increased DNA single strand breaks (Comet assay) and increased oxidative stress in

	2, or 4 h/day for 90 days; SAR brain 0.231 W/kg	brain.
*Shi et al (2014)	Cultured human lens epithelial cells (HLECs) exposed to 90 kHz magnetic field for 2 and 4 h; 93.36 μT	No significant effects on DNA single strand break (comet assay) and double strand breaks.
Smith-Roe et al. (2020)	Male and female Hsd:Sprague Dawley rats and B6C3F1/N mice exposed from Gestation day 5 or Postnatal day 35, respectively, to code division multiple access (CDMA) or global system for mobile modulations over 18 hr/day, at 10-min intervals for 19 (rats) or 14 (mice) weeks; SAR 1.5, 3, or 6 W/kg (rats, 900 MHz) or 2.5, 5, or 10 W/kg (mice, 1,900 MHz).	Significant increases in DNA single strand breaks (Comet assay) observed in the frontal cortex of male mice (both modulations), leukocytes of female mice (CDMA only), and hippocampus of male rats (CDMA only). No significant increases in micronucleated red blood cells were observed in rats or mice.
*Speit et al. (2007)	Human fibroblasts (ES1 cells) and Chinese hamster cells (V79) exposed to intermittent (5 min ON/10 min OFF)1800-MHz for 1, 4, 24 h; RFR; SAR 2 W/kg	No significant effects on DNA single strand break (Comet assay) and micronucleus frequency.
*Speit et al. (2013)	Human HL-60 exposed to intermittent (5 min ON/10 min OFF) 1800 MHz RFR for 24 r; SAR 1.3 W.kg	No significant effects on DNA single strand break (Comet assay) and micronucleus frequency.
*Stronati et al. (2006)	Human blood samples exposed to GSM 935-MHz signal for 24h;	Lymphocytes showed no changes in DNA sngle strand breaks (Comet assay), chromosomal aberrations, sister chromatid

	SAR 1 and 2 W/kg	exchanges, micronuclei frequency and cell cycle. No significant interaction with x-ray.
Sun C. et al. (2016)	Mouse embryonic fibroblasts (MEFs) with proficient ($Atm^{+/+}$) or deficient ($Atm^{-/-}$) ataxia telangiectasia mutated, which is critical to initiation of DNA repair, to GSM 1800-MHz RFR for 1, 12, 24, or 36 h; SAR 4 W/kg.	Increased DNA single-strand breaks (SSBs) (Comet assay) and activated the SSB repair mechanism. This effect reduced the DNA damage to less than that of the background level after 36 hours of exposure. In the $Atm^{-/-}$ MEFs, the same RF-EMF exposure for 12 h induced both DNA single and double-strand breaks (Comet assay) and activated the two repair processes, which also reduced the DNA damage to less than the control level after prolonged exposure. (compensatory effects) (Conclusion from interpretation f different results from ($Atm^{+/+}$) and ($Atm^{-/-}$) cells.
Sun, LX et al. (2006a)	Human lens epithelial cells exposed to 217 Hz-modulated 1800 MHz RFR for 2 h; SAR 1, 2, 3, 4 W/kg	No or repairable DNA single strand breaks (Comet assay) was observed after 2 hour irradiation of 1.8 GHz microwave on LECs when SAR </= 3 W/kg. The DNA damages caused by 4 W/kg irradiation were irreversible.
Sun, LX et al. (2006b)	Human lens epithelial cells exposed to 217 Hz-modulated 1800 MHz RFR for 2 h; SAR 1, 2, 3, 4 W/kg	No DNA single strand breaks (comet assay) was induced using comet assay after 2 hours irradiation of 1. 8 GHz microwave on hLECs at the dose SAR < or = 3.0 W/kg. 4.0 W/kg irradiation caused significantly DNA damage and inhibition of hLECs proliferation.
Tice et al. (2002)	Human blood leukocytes and lymphocytes exposed to voice modulated 837 MHz produced by an analog signal generator or by a time division multiple access (TDMA) cellular	No significant effect son DNA single strand break (Comet assay). Exposure to each of the four RF signal technologies for 24 h at an average SAR of 5.0 or 10.0 W/kg resulted in a significant and reproducible increase in the frequency of micronucleated lymphocytes.

	telephone, 837 MHz generated by a code division multiple access (CDMA) cellular telephone (not voice modulated), and voice modulated 1909.8 MHz generated by a global system of mobile communication (GSM)-type personal communication systems (PCS) cellular telephone for 3 or 24 h, SAR 1-10 W/kg	
Tiwari et al. (2008)	Blood samples from male human subjects exposed to a CDMA cell phone for 1 h	In vitro exposure to RFR induces reversible DNA single strand breaks (Comet asay) in synergism with aphidicolin, a DNA repair inhibitor,
Tkalec et al. (2013)	Earthworm (Eisenia fetida) exposed to comtinupus-wave and AM-modulated 900-MHz RFR for 2 - 4 h; SAR 0.00013, 0.00035, 0.0011, and 0.00933 W/kg	Increased DNA single strand breaks (Comet assay) in earthworms coelomocytes and oxidative stress (lipid and protein oxidation)
Trosic et al. (2011)	Male Wistar rats exposed to GSM 915 MHz RFR for 1 h /day 7 days/week for 2 weeks; SAR 0.6 W/kg	Incresaed DNA single strand breaks (Comet assay) in brain, renal, and liver cells.
Tsybulin et al. (2013)	Japanese Quail Embyos exposed in ovo to GSM 900 MHz signal from a cell phone intermittently (48 sec ON/12 sec OFF)	The lower duration of exposure led to a significant ($p < 0.001$) decrease in DNA single strand breaks (Comet assay) in cells of 38-h embryos, while the higher duration of exposure resulted in a significant increase

	during initial 38 h of brooding or for 158 h (120 h before brooding plus initial 38 h of brooding): SAR 0.000003 W/kg	in DNA damage.
Usikalu et al., (2013)	Sprague-Dawley rats exposed to 2450 MHz RFR for 10 min: SAR 0-4.3 W/kg	Increased DNA single strand breaks (Comet assay) found in ovary and testis.
*Valbonesi et al. (2008)	Human trophoblast cell line HTR-8/SVneo exposed to pulsed 1817 MHz RFR or 1 h; SAR 2 W/kg	No significant change in either HSP70 or HSC70 protein or gene expression, or DNA single strand breaks (Comet assay).
*Verschaeve et al. (2006)	Female rats exposed to RF fields for 2 h per day, 5 days per week for 2 years; SAR 0.3 or 0.9 W/kg. the mutagen and carcinogen 3-chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone (MX) was given in the drinking water. at a concentration of 19 mug/ml.	Nosignificant genotoxic activity of MX in blood and liver cells measured byy micronucleus and DNA simgle strand breas (comet assay). However, MX induced DNA damage in rat brain. Co-exposures to MX and RF radiation did not significantly increase the response of blood, liver and brain cells. (no data on RFR alone.)
*Vijayalaxmi et al. (2000)	3 human peripheral blood samples exposed to pulsed 2450-MHz RFR for 2 h; SAR 2.135 W/kg	No significant effect on DNA single strand breaks (Comet assay) was observed in lymphocytes immediately and at 4 h post-exposure.
Vilic et al. (2017)	Honey bee (Apis mellifera) larvae exposed to 900 MHz at field levels of 10, 23, 41 and 120 V m^{-1} for 2 h. At a	DNA single strand break (Comet assay) increased significantly in honey bee larvae exposed to modulated (80% AM 1 kHz sinus) field at 23 V m^{-1}. Oxidative changes also observed. Modulated RF-EMF produced

	field level of 23 V m^{-1} the effect of 80% AM 1 kHz sinusoidal and 217 Hz modulation was investigated as well.	more negative effects than the corresponding unmodulated field.
*Waldmann et al. (2013)	Human peripheral blood samples exposed to GSM 1800 MHz RFR for 28 h; SAR 0.2, 2, and 10 W/kg	No significant effects in lymphocytes on chromosome aberration, micronucleus frequency, sister chromatid exchange and DNA single strand break (comet assay).
Wang et al. (2015)	Neuro-2a (mouse neuroblastoma) cells exposed to GSM 900 MHz RFR for 24 h; SAR 0.5, 1 or 2 W/kg	Increased DNA oxidative damage (comet assay) and reactive oxygen species. OGG1(a base excision DNA repair enzyme) may be involved.
Wu et al. (2008)	Human lens epithelial cells exposed to 1800 MHz mobile phone radiation for 24 h; SAR 4 W/kg	Increased DNA single strand breaks (Comet assay) and reactive oxygen species.
Xu et al. (2013)	Six different types of cells intermittently (5 min ON/10 min OFF) exposed to pulsed GSM 1800 MHz RFR for 1 or 24 h: SAR 3.0 W/kg	RFR induced DNA damage (γH2AX foci and alkaline and neutral comet assay) in a cell type-dependent manner.
Yakymenko et al. (2018)	Quail embryos exposed to GSM 1800 GHz signal from a smart phone (48 s ON/12 s OFF) for5 days before and 14 days during incubation , power density 0.00032 mW/cm^2	Increased DNA single sand breaks (comet assay), oxidative DNA damage, reactive oxygen species, and mortality.
Yao et al. (2008)	Human lens epithelial cells intermittently (5 min ON/10 min OFF)	Increased DNA single strand breaks (Comet assay), no change in double strand breaks (γH2AX foci), and increased reactive

	exposed to GSM 1.8 GHz RFR for 2 h; SAR 1, 2, 3, and 4 W/kg	oxygen species.
Ye et al. (2016)	Chicken embryos exposed to GSM 900 MHz RFR from cell phones 3 h/day from day 2 to day 21 of incubation	Increased DNA single strand breaks (Comet assay) from blood cells and mortality.
*Zeni et al. (2005)	Human peripheral blood lymphocytes exposed to GSM 900 MHz signal for 2 h; SAR 0.3 and 1 W/kg	No significant effects on DNA single strand breaks (Comet assay), chromosome aberration, or sister chromatid exchange.
*Zeni et al. (2007)	Human whole blood samples exposed to 120 GHz (SAR 0.4 W/kg) and 130 GHz (SAR 0.24, 1.4, or 2 W/kg) RFR for 20 min.	No effects in leukocytes on micronucleus frequency and DNA single strand braeks (comet assay).
*Zeni et al. (2008)	Human peripheral blood exposed intermittently (6 min ON/2 h OFF) to 1945 MHz RFR for 24 – 68 h; SAR 2.2 W/kg	No significant effects on DNA single trand breaks (Comet assay) and micronucleus frequency in leukocytes.
Zhang et al. (2002)	Human whole blood exposed to 2450 MHz RFR for 2 h; Power density 5 mW/cm^2	2450-MHz RFR cannot induce DNA and chromosome damage, but can increase DNA single strand breaks (Comet assay) induced by mitomycin C .
*Zhijian et al. (2009)	Leukocytes from four young healthy donors exposed intermittent (5 min ON/10 min OFF) to 1800 MHz RFR for 24 h; SAR 2 W/kg; Cell also exposed x-ray	No significant effect on DNA single strand breaks (Comet assay) and no synergistic effect with x-ray.

*Zhijian et al. (2010)	Human B-cell lymphoblastoid cells exposed to 1800 GHz RFR for 2 h; SAR 2 W/kg	RFR did not directly induce DNA single strand breaks (Comet assay)
Zong et al. (2015)	Mice exposed to 900 MHz RFR 4 h/day for 7 days; SAR 0.05 W/kg	RFR alone had no effect on DNA single strand breaks (Comet assay) and oxidative damage in blood leukocytes. It attenuated bleomycin-induced DNA breaks and repair, and oxidative damage.
*Zuo et al. (2015)	Sprague-Dawley rat spiral ganglion neurons exposed intermittently (5 min ON/10 min OFF) to GSM 1800 MHz RFR for 24 h; SAR 2 and 4 W/kg	The RFR could not directly induce DNA single strand breaks (Comet assay) in normal spiral ganglion neurons, but it could cause the changes of cellular ultrastructure at SAR 4.0 W/kg when cells are in fragile or micro-damaged condition.

Table 2. Static and ELF EMF studies that used the Comet assay. (*study with no effect observed); Number of papers that showed effects = 46 (73%); no effect = 17 (27%)

	Exposure conditions	**Results**
Ahuja et al. (1999)	Human peripheral blood samples exposed to 50 Hz EMF at 2, 3, 5, 7, or 10 mT	Increased DNA single strand breaks (Comet assay) in lymphocytes.(Damage levels higher in female than in male subjects.)
*Albert et al. (2009) (McNamee)	Human subjects exposed to exposed to 60-Hz magnetic field at 0.2 mT for 4 h	No significant effect on DNA single strand breaks (Comet assay) and micronucleus frequency in lymphocytes.
Al-Huqail and Abdelhaliem (2015)	Maize seedlings exposed to 50-Hz electric field at 6 kV/m for 1, 3, or 5 days	Increased DNA single strand breaks (comet assay)
Amara et al. (2007a)	Human monocytic leukemia THP-1 cells exposed to static magnetic field at 250 mT for 1, 2, or 3 h	Lower level of DNA single strand breaks (Comet assay) at 3 h of exposure, no effect on oxidative damages and enzymes and oxidative DNA damage.
Bagheri Hosseinabadi et al. (2019)	Blood samples from 102 thermal power plant workers as the exposure group and 136 subjects as the unexposed group.	Increased DNA single strand breaks (Comet assay) in lymphocytes of exposed subjects.
Bagheri Hosseinabadi et al. (2020)	Blood samples from thermal power plant workers; mean levels of exposure to ELF magnetic and electric fields were .0165 mT (±6.46) and 22.5 V/m	DNA single strand breaks (Comet assay) in lymphocytes decreased by antioxidants.

	(±5.38), respectively,	
Buddak et al. (2012)	Murine AT478 carcinoma cells cultured with cisplatin exposed to 50-Hz EMF for 16 min at1 mT	Exposure to ELF-EMF alone resulted in an increase in DNA single strand breaks (Comet assay) compared to control cells. ELF-EMF lessened the effects of oxidative stress and DNA damage that were induced by cisplatin; however, ELF-EMF alone was a mild oxidative stressor and DNA damage inducer. The addition of ELF-EMF exposure to cisplatin treatment resulted in decreased ROS levels and antioxidant enzyme activity.
*Cantoni et al.(1996)	Cultured mammalian cells exposed to 50 Hz electric (0.2 - 20 kV/m), magnetic (0.0002- 0.2 mT), or combined electric and magnetic fields.	Repair of DNA single strand breaks (Comet assay) induced by the carcinogens methylmethane sulphonate (MMS), chromate, and 254 U.V. radiation not affected by ELF EMF exposure.
Chen WF et al. (2010)	Human myelogenous leukemia K562 cells exposed tostatic magnetic field at 8.8 mT with or without cisplatin	Static magnetic field exposure induced DNA to become thicker than controls, and enhanced DNA breakage (Comet assay) induced by cisplatin.
Cho S et al. (2014)	Human lymphocytes exposed to 60-Hz EMF at 0.8 mT for 12-72 h with or without gadolinium.	ELF-EMF increased cell death, micronucleus frequency, DNA single strand break (Comet assay), and apoptosis induced by gadolinium.
Delimaris et al. (2006)	Human lymphocytes exposed to 50-Hz pulsed electric fields (10-Hz carrier frequency) at 4 x 10^5 V/m for 120 min	Increased in DNA single strand breaks (Comet assay).

Duan et al. (2015)	A mouse spermatocyte-derived GC-2 cell line intermittently (5 min on and 10 min off) exposed to a 50 Hz EMF at 1, 2 or 3 mT for 24 h	Increased DNA strand breaks (Comet assay and gamma H2AX foci) at 3 mT exposure.
El-Bialy and Rageh (2013)	Mice with Ehrlich tumors exposed to a 50-Hz magnetic field 1 h/day for 2 weks at 10 mT	Exposure cause DNA single strand breaks (Comet assay) in tumor cells and increased micronucleus frequency in bone marrow cells. ELF-MF enhanced the effects of cisplatin.
*Fairbairn and O'Neill (1994)	Human cells exposed to ELF-EMF	No significant effect on DNA single strand breaks (Comet assay)
Focke et al. (2010)	Human fibroblasts exposed to intermittent (5 min ON/10 min OFF) 50-Hz EMF at 1 mT for 15 h	Increased DNA single strand breaks (Comet assay) caused by magnetic and not electric field, No oxidative DNA damage. Could be caused by minor disturbances in S-phase processes and occasional triggering of apoptosis rather than by the generation of DNA damage.
*Frazier et al. (1990)	Human lymphocytes induced with DNA damage with ionizing radiation were exposed to 60-Hz magnetic field at 1 mT, electric field at 1 or 20V/m, or combinations of magnetic and electric fields (0.2 V/m and 0.05 mT, 6 V/m and 0.6 mT, or 20 V/m and 1 mT) up to 180 min.	EMF exposure did not affect repair of DNA single strand breaks (Comet assay).
Hong et al. (2005)	Mice exposed to a 50-Hz EMF at 0.2 or 6.4 mT for 4 weeks	EMF induced DNA single strand breaks (Comet assay) in testicular cells and chromatin condensation in spermatozoa.

Ivancsits et al. (2002)	Human diploid fibroblasts exposed to continuous or intermittent (5 mon ON/10 min OFF) 50-Hz EMF at 1 mT for 24 h	Intermittent exposure induced DNA single and double strand breaks (Comet assay).
Ivancsits et al. (2003a)	Human diploid fibroblasts exposed to intermittent (5 min ON/10 min OFF)50-Hz EMF at 0.02- 1 mT for 1-24 h	DNA Single and double strand breaks (Comet assay) observed at 0.035 mT at 15 h; recovered within 9 h.
Ivancsits et al.(2003b)	Fibroblasts from human subjects of different ages exposed to intermittent (5 min ON/10 min OFF) 50-Hz EMF at 1 mT for 1-24 h	Increased DNA Single and double strand breaks (Comet assay) at 15 h; more pronounced in cells from older donors
Ivancsits et al. (2005)	Various cell types exposed to intermittent (5 min ON/10 min OFF) 50-Hz EMF at 1 mT for 1-24 h	Effects on DNA Single and double strand breaks (Comet assay) showed three responder (human fibroblasts, human melanocytes, rat granulosa cells) and three non-responder cell types (human lymphocytes, human monocytes, human skeletal muscle cells).
Jajte et al. (2001)	Rat peripheral blood lymphocytes exposed to a 50-Hz magnetic field at 7 mT for 3 h	Increased DNA single strand breaks (Comet assay) in cells treated with ferrous chloride; melatonin attenuated the effect.
*Jin et al, (2014)	NIH3T3 mouse fibroblast cells, WI-38 human lung fibroblast cells, L132 human lung epithelial cells, and MCF10A human mammary gland epithelial cells exposed	No significant effect on DMA single strand breaks (Comet assay), and interaction with ionizing radiation, H_2O_2, or c-Myc activation.

	to a 60-Hz magnetic field at 1 mT for 4 or 16 h	
Kim J. et al. (2012)	Human primary fibroblast and cervical cancer cells exposed to a time-varying 60-Hz magnetic field at 7 mT for 10-60 min,	DNA double strand breaks (gamma-H2AX foci and Comet assay) detected (intracellular reactive oxygen species not affected).
Kindzelskii and Petty (2000)	Human neutrophils exposed to pulsed square-wave (20 msec) DC electric field at 0.2 V/m for 30, 45, 60 min	Increased DNA single strand breaks (Comet assay).
Kubinyi et al. (2010)	Human lymphocytes exposed to an inhomogeneous static magnetic field with a lateral magnetic flux density gradient of 47.7, 1.2, or 0.3 T/m by 10 mm lateral periodicity, or a homogeneous SMF of 159.2 mT magnetic flux density for a time period of 0.5 min, 1, 2, 4, 6, 18, 20, or 24 h.	Increased DNA single strand breaks (Comet assay); affected DNA repair induced by gamma ray when exposure occurred after ionizing radiation treatment.
Lai and Singh (1997a)	Male Sprague-Dawley rats exposed to a 60-Hz magnetic field at 0.1, 0.25, or 0.5 mT for 2 h	Increased DNA single and double strand break (Comet assay) in brain cells.
Lai and Singh (1997b)	Male Sprague-Dawley rats exposed to a 60-Hz magnetic field at 0.5 mT for 2 h	Increased DNA single and double strand break (Comet assay) in brain cells. Effects blocked by melatonin and a spin-trap compound.
Lai and Singh (2004)	Male Sprague-Dawley rats exposed to a 60-Hz	Increased DNA single and double strand break (Comet assay) in brain cells. More

	magnetic field at 0.01 mT for 24 or 48 h	effect with 48-h than 24-h exposure. Effects blocked by Trolox (a vitamin E analog) and 7-nitroindazole (a nitric oxide synthase inhibitor).
Lee et al. (2011)	Human lymphocytes exposed to EMF generated during MRI scanning (clinical routine brain examination protocols: three-channel head coil) for 22, 45, 67, and 89 min.	Significant increases in DNA single-strand breaks (Comet assay), and frequencies of both chromosome aberrations and micronuclei in a time-dependent manner.
*Luceri et al. (2005)	Human peripheral blood lymphocytes and DBY747 Saccharomyces Cerevisiae exposed to a50-Hz magnetic field at 0.001, 0.01or 0.1 mT for 18 h.	No significant effects on DNA single strand breaks (Comet assay), oxidated DNA base, and gene expression.
Luukkonen et al. (2017)	Human SH-SY5Y neuroblastoma cells. Exposed to a 50-Hz magnetic field at 0.1 mT for 24 hours, followed by menadione exposure for 1 or 3 hours.	Decreased p21 protein (a DNA damage response-related proteins) level after 1-h menadione treatment, as well as increased proportion of cells in the G1 phase and decreased proportion of S phase cells after 3-h menadione treatment. Magnetic field exposure decreased DNA single strand breaks (Comet assay) caused by I h treatment with menadione.
Mariucci et al. (2010)	CD1 mice exposed to a 50-Hz magnetic field at 1 mT for 1 or 7 days (15 h/day)	Increased DNA single strand breaks (Comet assay) in brain areas detected immediately after 7-day exposure. No effect on HSP-70 expression.

*McNamee et al. (2002)	10-day-old mice exposed to a 60-Hz magnetic field at 1 mT for 2 h, cerebellum assayed at 0. 2, 4, and 24 h after exposure	DNA sungle strand breaks (Comet assay): "While increased DNA damage was detected by tail ratio at 2h after MF exposure, no supporting evidence of increased DNA damage was detected by the other parameters." "Taken together, these results do not support the hypothesis that acute MF exposure causes DNA damage in the cerebellums of immature mice." No change in apoptosis.
*McNamee et al. (2005)	Rodents (adult rats, adult mice, and immature mice) exposed to a 60-Hz magnetic field at 0.1, 1 or 2 mT for 2 h. Assayed at 0, 2 and 4 h after exposure.	This study provided no evidence of magnetic-field-induced DNA single strand breaks (Comet assay) in the brain.
Miyakoshi et al. (2000)	Human glioma MO54 cells exposed to a 50-Hz magnetic field at 55, 50, or 400 mT at 4^0C or on ice. For 30 min.	Exposure to magnetic field at more than 50 mT potentiated X-ray-induced DNA single strand breaks (Comet assay).
Moretti et al. (2005)	Jurkat cells exposed to a 50-Hz magnetic field at 1 mT for 1 h with added xenobiotics	Magnetic field exposure enhanced genotoxic effects (DNA single strand breaks (Comet assay)) of xenobiotics.
Nakayama et al. (2016)	Macrophages stimulated with the bacterial endotoxin, lipopolysaccharide and posed to a 50-Hz magnetic field at 0.5 mT for 24 h	Increased DNA single strand breaks (Comet assay) and decreased viability.

Nikolova et al. (2005)	Mouse embryonic stem (ES) cells exposed to an intermittent (5 min ON/30 min OFF) 50-Hz EMF at 2 mT for 6 or 48 h	Significantly affected transcript levels of the apoptosis-related bcl-2, bax, and cell cycle regulatory "growth arrest DNA damage inducible" GADD45 genes, No effect on DNA single and double strand breaks (Comet assay).
Pilger et al. (2004)	Human fibroblasts exposed to an intermittent (5 min ON/10 min OFF) 50-Hz EMF at 1 mT for 15 h	Exposure resulted in an increase in DNA single strand breaks (Comet assay) unlikely to be caused by intracellular changes that affect intracellular [Ca2+] or mitochondrial membrane potential.
Rageh et al. (2012)	Newborn rats (10 days after delivery) exposed continuously to a 50 Hz magnetic field at 0.5 mT for 30 days	Increased DNA single strand breaks (Comet assay) in brain cells and micronucleus frequency in bone cells. Changes in anti-oxidative enzymes and increased lipid peroxidation.
*Reese et al. (1998)	Chinese hamster ovary (CHO) cells exposed to 60-Hz magnetic fields (0.1 or 2 mT), electric fields (1 or 38 V/m), or combined magnetic and electric fields (2 mT and 38 V/m, respectively) for 1 h.	No significant effect on DNA single strand breaks (Comet assay) from exposures.
Robison et al. (2002)	HL-60, HL-60R, and Raji cell lines exposed to a 60-Hz EMG at 0.15 mT for 24 h	EMF exposure offers significant protection from apoptosis (DNA double strand breaks (Comet assay)) and significantly decreased DNA repair rates in HL-60 and HL-60R cell lines but not in the Raji cell line.
*Scarfi et al (2005)	Human diploid fibroblasts exposed to an intermittent (5 min ON/10 min OFF) 50-Hz EMF or a 50-Hz field plus its harmonics for 24	No significant effects on DNA single strand breaks (Comet assay) and micronucleus frequency.

	h (1,2,4-BT) also studied.	
Scassellati Sforzolini et al. (2004)	Cells exposed to a 50-Hz magnetic field at 5 mT; co-genotoxic effects with N-methyl-N'-nitro-N-nitrosoguanidine (MNNG), 4-nitroquinoline N-oxide (4NQO), benzene, 1,4-benzenediol (1,4-BD), or 1,2,4-benzenetriol	Magnetic field showed genotoxic (micronucleus test) and co-genotoxic (comet assay) capabilities.
Singh and Lai (1998)	Rats exposed to a 60-Hz magnetic field at 0.5 mT for 2 h.	Data suggested that both DNA-protein and DNA-DNA crosslinks (Comet assay) were formed in brain cells.
*Stronati et al. (2004)	Human whole blood exposed to a 50-Hz magnetic field at 1 mT for 2 h.	No significant effects on DNA single strand breaks (Comet assay), sister chromatid exchanges, chromosome aberrations, and micronucleus frequency in lymphocytes. A slight decrease in cell proliferation observed.
Sun RG et al.(2012)	K562 human leukemia cells exposed to paclitaxel in the presence or absence of 8.8 mT static magnetic field for 24 h	The potency of the combination of SMF and paclitaxel was greater than that of SMF or paclitaxel alone on K562 cells, and these effects were correlated with DNA single strand breaks (Comet assay).
Svedenstal et al. (1999)	Brain cells of CBA mice exposed to a 50 Hz magnetic field at 0.5 mT 2 h, 5 days or 14 days.	DNA single strand breaks (Comet assay) increased after 14 days of exposure,
*Szerencsi et al. (2013)	Peripheral blood samples from men exposed to EMF produced by 3T magnetic resonance imaging equipment for 0, 22, 45, 67, and 89 min	No significant effect on DNA single strand breaks (Comet assay) and DNA integrity in lymphocytes.

	during the scanning procedure.	
Teodori et al. (2014)	Human glioblastoma cells exposed to static magnetic field at 80 mT for 6,12, or 24 h, alsoin combination with X-ray	Increased in DNA single strand breaks (Comet assay) after 24 h of exposure; x-ray induced DNA strand breaks significantly reduced by post-irradiation exposure to static magnetic field. Further data suggested that static magnetic field modulated DNA damage and/or repair, possibly through a mechanism that affects mitochondria.
*Tiwari et al. (2015)	Blood samples of human subjects occupationally exposed to 132 kV high-voltage substations (mean duration on job 9.27 years, range 2-30 years).	No significant effect on DNA single strand breaks (Comet assay) in lymphocytes, increased oxidative stress observed.
Udroiu et al. (2015)	Mice exposed to 50-Hz, 0.065 mT magnetic field, 24 hours/day, for a total of 30 days, starting from 12 days post-conception.	Magnetic field induced a slight genotoxic damage (micronucleus formaton) and no interaction with x ray in erythrocytes, but modulate the response of male germ cells to X-rays with an impact on proliferation/differentiation processes. Magnetic field exposure decreased DNA single and double strand breaks (Comet assay) in germ cells at 42 days after birth.
Villarini et al. (2006)	Human leukocytes exposed to a 50-Hz magnetic field at 3 mT for 30, 60, or 120 min and treated with mutagens.	Magnetic field exposure increased N-methyl-N'-nitro-N-nitrosoguanidine- and decreased 4-nitroquinoline N-oxide-induced DNA single strand breaks (Comet assay).
Villarini et al. (2013)	Male CD1 mice exposed to a 50-Hz magnetic field at 0.1, 0.2, 1 or 2 mT for 7 days (15 hours/day) and sacrificed either at	Magnetic field exposure induced DNA single strand breaks (Comet assay) and did not affect hsp70 expression in the brain.

	the end of exposure or after 24 h.	
Villarini et al. (2015)	Blood leukocytes from electric arc welders presumably exposed to 50-Hz EMF(mean 0.0078 mT; range: 0.00003-0.171 mT)	Decreased DNA single strand beaks (Comet assay), may be caused by DNA-protein crosslinks by metal exposure.
*Villarini et al. (2017)	SH-SY5Y and SK-N-BE-2 human neuroblastoma cells exposed to a 50-Hz magnetic field at 0.01. 0.1, or 1 mT for 1 h continuously or 5 h intermittently (15 min ON/15 min OFF), and also aluminum	or $AlCl_3$ alone induced DNA single strand breaks (Comet assay), changes in GSH/GSSG ratio or variations in Hsp70 expression. Co-exposure to ELF-MF and $AlCl_3$ did not have any synergic toxic effects.
*Wang Y et al. (2019)	Human ventricular cardiomyocytes exposed to a 50-Hz magnetic field at 0.1 mT for 1 h continuously or 75 min intermittently (15 min ON/15 min OFF). Sprague-Dawley rats exposed to 50 Hz magnetic field at 0.1 mT for 15 h/day for 7 days.	Magnetic field exposure did not cause DNA single strand breaks (Comet assay) in heart cells in both in vitro and in vivo experiments.
Wolf et sl. (2005)	HL-60 leukemia cells, Rat-1 fibroblasts, and WI-38 diploid fibroblasts exposed to a 50-Hz EMF at 0.5-1 mT for 24-72 h	Dose-dependent increases in DNA single strand breaks (Comet assay) and formation of 8-hydroxy-2'-deoxyguanosine adducts were observed in all cell lines. There were increases in cell proliferation and reactive oxygen species.
Yin et al. (2016)	Primary cultured rat hippocampal neurons	Increase in DNA single strand breaks (Comet

	exposed to a 50-HZ EMF at mT for 90 min	assay); free radicals involved.
Yuan et al. (2020)	Tumor cell lines including lung cancer, gastric cancer, pancreatic cancer and nephroblastoma exposed to a 50-Hz EMF modulated by static MF with time-average intensity of 5.1 mT, for 2 h/day for 3 days.	Induced DNA single strand breaks (Comet assay), gamma-H2AX and activation of DNA repair pathways, increased reactive oxygen species and ferroptosis, and decreased proliferation.
Zendehdel et al. (2019)	Peripheral blood cells of male power line workers in a power plant. The median value of the magnetic field at the working sites was 0.00085 mT.	Increased in DNA single strand breaks (Comet assay).
*Zhu et al. (2016)	Human lens epithelial cells exposed to a 50-Hz magnetic field at 0.4 mT for 2, 6, 12, 24, or 48 h	No effect on DNA single strand breaks (Comet assay) and gamma-H2AX foci.
Zmyslony et al. (2000)	Rat lymphocytes exposed to a static or50-Hz magnetic field at 7 mT for 3 h	In combination with $FeCl_2$, increases in DNA single strand breaks (Comet assay) observed for both static and 50-Hz field exposure.
Zmyslony et al. (2004)	Rat lymphocytes exposed first to ultraviolet radiation and then to a 50-Hz magnetic field at 0.04 mT for 5 or 60 min	60-min magnetic field exposure (plus UVA) caused an increase in DNA single strand breaks (Comet assay). MF may affect the radical pairs generated during the oxidative or enzymatic processes of DNA repair.