Supplemental Table S1. Mammalian *In Vivo* Studies Published Since the EPA and IARC Reviews of Glyphosate and Formulated GBH Genotoxicity*

Citation [Reference Number from Benbrook et al., 2023]	Compound Tested	Concentration(s)	Test Target	Assay	Results***
			Mammalian *In Vivo*		
Kasuba et al. 2017 [59]	Glyphosate technical	0.5, 2.91, and 3.5 µg/mL	Human	CBMN	**Positive.** Oxidative stress (all conc.)
Larsen et al. 2022 [60]	Glyphosate technical	20 and 200 ppm	Pigs	DNA methylation	**Negative**; no significant changes in global DNA methylation in small intestines, kidneys or livers. However, differences in the absolute value of global DNA methylation were seen between the three organs. Whereas DNA methylation rates were around 1% (0.8%− 1.2%) in the small intestines and kidney tissues, a higher value of around 3% was observed in liver tissue
Mesnage et al 2022[61]	Glyphosate technical	50 mg/kg bw/day glyphosate	Liver and kidney of female Sprague Dawley rat	Aprurini/apyrimidinic site formation	**Positive.** Glyphosate induced more apurinic/ apyrimidinic DNA damage formation in liver than MON 52276.
Milic et al. 2018 [62]	Glyphosate technical	0.1, 0.5, 1.75, and 10 mg/kg/day	Wistar rat	Comet assay	**Positive**, DNA damage in leukocytes and liver cells (all conc.)
Tarboush et al. 2022 [63]	Glyphosate technical	20, 40, 200 µmol/L	Human Lymphocytes	Sister-chromatid exchange assay Chromosomal aberration assay 8-OHdG assay	**Positive**; glyphosate induced significant slight increases in the levels of SCE only at the highest concentration (200 µmol/L) Negative, Chromosomal aberration assay, no significant changes in CA were detected at all concentrations Negative; Glyphosate did not cause any changes in the level of 8-OHdG at all concentrations.
Avdatek et al. 2018 [64]	GBH (Knockdown 48 SL)	375 mg/kg/day	Wistar Albino rats	Single cell gel electrophoresis (comet) assay	**Positive**; High levels of DNA damage were detected .
de Maria Serra et al. 2022 [65]	GBH (Roundup® Original)	3.71 × 10−3, 6.19 × 10−3 and 9.28 × 10−3 grams of active ingredient per hectare (g.a.i./ha),	Male and female Wistar rats	Bone marrow micronucleus assay	**Positive**; a greater number of micronuclei were detected in females exposed to the low oral concentration, and the number was higher in males exposed to the high inhalation concentration.
Hutter et al. 2018 [66]	GBH	Unknown applicator exposure	Human	Micronucleus (MN) assay	**Positive**
Kupske et al. 2021 [67]	GBH	Unknown applicator exposure	Human	Micronucleus (MN) assay	**Positive**
Leite et al. 2019 [68]	GBH	Unknown children exposure	Human	Micronucleus (MN) assay	**Positive**
Lucia et al. 2022 [69]	GBH	0:12 - 1:65 ng/mL	postmenopausal women	DNA methylation	**Positive**. Roundup exposure was associated with DNA methylation differences that could promote the development of cancer and other diseases.
Makris et al. 2022 [70]	GBH	0.10, 0.29 µg/L	Human	Immunoassay	Negative for glyphosate, **Positive** for AMPA. Significant association was observed between AMPA and DNA oxidative damage marker (8-OHdG).
Mesnage et al 2022 [61]	GBH [MON 52276 (Roundup Bio Flow)]	50 mg/kg bw/day glyphosate	Liver and kidney of female Sprague Dawley rat	Aprurini/apyrimidinic site formation	**Negative**
Rossi et al. 2018 [71]	GBH (Roundup® Full II)	0.260, 0.053, 0.106, 0.379 mL	Armadillo (*Chaetophractus villosus*)	Chromosomal aberration	**Positive**; significant changes in sister chromatid exchange (SCE) at all concentrations.
Schnabel et al, 2020 [72]	GBH (Roundup record)	122.7 µg glyphosate/kg BW	Lactating German Holstein dairy cows	Comet assay	**Negative**; no genotoxic effects probably due to exposure that was 20 to 12,711 times lower compared to the discussed studies showing genotoxic effect
Soudani et al. 2019 [73]	GBH	50 mg/kg b.w	Albino rats	Comet assay	**Positive**; the herbicide induced oxidative DNA damage
Glyphosate Technical**				**Number of Assays**	**5**
				Positive	**4**
				Percent Positive	**80%**
Formulated GBHs**				**Number of Assays**	**11**
				Positive	**9**
				Percent Positive	**82%**
All New Studies				**Number of Assays**	**16**
				Positive	**13**
				Percent Positive	**81%**

* Final PubMed literature search performed on 04/10/2022.

**Some studies included assays on both glyphosate technical and formulated GBHs, the results of which are reported separately in this and other tables. For this reason, the number of assay results on glyphosate technical and/or formulated GBHs exceeds the total number of new studies.

*** Some studies report results of multiple assays. The "Results" column reports major results by assay type. "Positive" assays include those for which one or more positive response is reported. The evaluation of whether an assay is "Positive" or "Negative" is indicated in bold.

Supplemental Table S2. Mammalian *In Vitro* Studies Published Since the EPA and IARC Reviews of Glyphosate and Formulated GBH Genotoxicity*					
Citation [Reference Number from Benbrook et al., 2023]	**Compound Tested**	**Concentration(s)**	**Test Target**	**Assay**	**Result*** **
Mammalian *In Vitro*					
Alvarez-Moya et al. 2022 [74]	Glyphosate technical	0.07, 0.7 and 7 (human lymphocytes); 0.03, 0.05 and 0.07 (Ambystoma mexicanum and Oreochromis niloticus erythrocytes) mM.	erythrocytes of *Oreochromis niloticus* , *Ambystoma mexicanum* and human lymphocytes.	Comet assay	**Positive**; The 0.03, 0.05 and 0.07 mM concentrations of glyphosate induced significant genotoxic activity in human lymphocytes and in erythrocytes of the species studied.
Anifandis et al. 2018 [75]	Glyphosate technical	0.36 mg/L glyphosate	Human semen	Halosperm® G2 Kit.	**Negative**; glyphosate exerts toxic effects on sperm progressive motility but not on sperm DNA integrity
Barron Cuenca et al. 2022 [76]	Glyphosate technical	0.001, 0.01, 0.07 mM	Human liver HepG2 cells	Comet assay	**Negative**; no DNA damage. But a mixture of glyphosate, paraquat and cypermethrine induce DNA damage
Hao et al. 2020 [77]	Glyphosate technical	100 µg/mL	Human alveolar carcinoma A549 cell line	comet assay (single-cell electrophoresis assay)	**Negative**; Glyphosate alone did not induce oxidative DNA damage in the A549 cells.
Kasuba et al. 2017 [59]	Glyphosate technical	0.5, 2.91, and 3.5 µg/mL	Human HepG2 cells	Cytokinesis-block micronucleus (CBMN) cytome assay	**Positive**; a significantly higher number of MN and nuclear buds indicating DNA damage at 0.5 and 2.91 µg/mL
Kwiatkowska et al. 2017 [78]	Glyphosate technical	0.1-10 mM	Human peripheral blood mononuclear cells	Comet assay	**Positive;** DNA damage (at 0.5-10 mM doses)
Mesnage et al 2022 [61]	Glyphosate technical	500, 1000, 1500, 2000 and 2500 µM	Mouse embryonic stem (mEs) reporter cell line	ToxTracker Assay	**Negative**
Mesnage et al. 2022 [79]	Glyphosate technical	1000, 2000, 3000, 4000 and 5000 µM	Human intestinal epithelial Caco-2 and hepatocyte HepG2 cell lines	ToxTracker assay	**Positive**; glyphosate induced oxidative stress in HepG2 cells.
Milic et al. 2018 [62]	Glyphosate technical	0.1 mg/kg bw/ day (AOEL), 0.5 mg/kg bw/day (ADI), 1.75 mg/kg bw/day (cPAD), and 10 mg/kg bw per day (100xAOEL).	leukocytes and liver tissue of Wistar rats	Alkaline comet assay	**Positive**; all treatments (mostly at 0.1 and 10 mg/kgbw/day) resulted in significantly higher primary DNA damage in the liver cells and leukocytes.
Nagy et al 2021 [80]	Glyphosate technical	0.1, 1, 10, 100 µM	Human peripheral white blood cells	Cytokinesis-block micronucleus assay	**Positive**; Glyphosate increased MN frequency only at 100 µM
Olah et al. 2022 [81]	Glyphosate technical	10-6 -101 Roundup equivalent concentration	osteoblastic cell line (MC3T3-E1) and neuroectodermal stem cell-like (NE-4C)	Comet assay and Flow cytometry	**Positive**; marked DNA damage in exposed cells
Rice et al. 2018 [82]	Glyphosate technical	0.0007-33 mM	Human HepaRG and HaCaT cell lines	CellTiter-Glo, ROS-Glo, and JC10	**Positive**, oxidative stress (pure glyphosate ≥ 10 mM, formulations all conc.)
Santovito et al. 2018 [83]	Glyphosate technical	0.500, 0.100, 0.050, 0.025, and 0.0125 µg/mL	Human lymphocytes	Chromosomal aberration, micronuclei	**Positive**; chromosomal aberration (CA) and micronuclei (MNi) frequencies significantly increased at all tested concentrations, with exception of 0.0125 µg/mL
Suárez-Larios et al. 2017 [84]	Glyphosate technical	0, 0.4, 2, 10, 50 µM	Human lymphocytes	Immunofluorescence detection of Phosphorylated histone H2AX foci	**Positive**; glyphosate induced double-strand breaks (DSB) and a significant increase of p-Ku80 protein.
Szepanowski et al. 2018 [85]	Glyphosate technical	0.0005-0.005% of culture medium	Human dorsal root ganglia cultures	Mylenation	**Negative**
Townsend et al. 2017 [86]	Glyphosate technical	0.1 µM - 15 mM	Human Raji cells	Comet assay	**Positive**, glyphosate treatment is lethal to Raji cells at concentrations above 10mM, yet has no cytotoxic effects at concentrations at or below 100µM. concentrations of 1mM and 5mM induce statistically significant DNA damage following 30 to 60 minutes of treatment.
Wozniak et al. 2018 [87]	Glyphosate technical and AMPA	1 to 1000 µM	Human peripheral blood mononuclear cells	Breaks in peripheral mononuclear cells	**Positive**, DNA damage (glyphosate ≥ 250 µM, AMPA ≥ 500 µM)
Wozniak et al. 2021 [88]	Glyphosate technical and AMPA	Glyphosate (0.5 to 100 µM); AMPA (0.5, to 250 µM)	human peripheral blood mononuclear cells (PBMCs)	Gene profiling	**Positive**; glyphosate changed the expression of DNMT1, DMNT3A, and HDAC3, while AMPA changed the expression of DNMT1 and HDAC3. The results also revealed that glyphosate at lower concentrations than AMPA upregulated the expression of the tested genes.
Zhang et al. 2019 [89]	Glyphosate technical	500 µM Glyphosate	Mouse Oocytes	Comet assay	**Negative**; no DNA damage but increased oxidative stress.
Bhardwaj et al. 2019 [90]	GBH	0.1, 2.0, and 4.0 mg/ml	granulosa cells of goat	EB/AO differential staining-fluorescence assay	**Positive**; increase in the incidence of apoptotic attributes within granulosa cells as well as oxidative stress with increasing dose and duration of the GBH treatment.

Citation [Reference Number from Benbrook et al., 2023]	Compound Tested	Concentration(s)	Test Target	Assay	Result***
De Almeida et al. 2018 [91]	GBHs (Roundup® and Wipeout®)	10-500 µg/mL	Human cancer cells (the estrogen-E2-responsive HEC1A, MCF7 and the estrogen-insensitive MDA-MB-231)	Comet assay	**Positive** At 500 µg/ml, glyphosate demonstrated DNA damage in the HEC1A and MDA-MB-231 cells. Adjuvants and/or glyphosate impurities were potential contributing factors of toxicity based on the differential toxicities displayed by Roundup and Wipeout in human whole blood and the HEC1A cells.
Hao et al. 2019 [92]	GBH (Roundup)	50, 75, 100 and 125 mg/mL	Human alveolar carcinoma cells (A549 cells).	Alkaline comet assay	**Positive**; Roundup caused concentration dependent increases in DNA damages and proportion of apoptotic cells in A549 cells.
Hao et al. 2020 [77]	GBH (Roundup)	100 µg/mL	Human alveolar carcinoma A549 cell line	comet assay (single-cell electrophoresis assay)	**Positive**; oxidative DNA damage, DNA single-strand breaks and double-strand breaks are occurred in Roundup and POEA treated A549 cells.
Luaces et al. 2017 [93]	GBH (Roundup Full II®)	280, 420, 560, 1120 µmol/L	Peripheral blood lymphocytes of Armadillo (*Chaetophractus villosus*)	Chromosomal aberration (CA) and sister chromatid exchanges (SCE) assay	**Positive**; Significant increases seen in the CA frequency and the mean number of SCEs per cell at all concentrations tested.
Luo et al. 2017 [94]	GBH (Roundup®)	Not provided in abstract.	Human	L-02 hepatocytes	**Positive**, oxidative stress
Mesnage et al. 2022 [79]	GBH [MON 52276 (Roundup Bio Flow); MON 76473 (Roundup ProBio); MON 76207 (Roundup PROMAX)]	500, 1000, 1500, 2000 and 2500 µM	Mouse embryonic stem (mEs) reporter cell line	ToxTracker Assay	**Positive**; MON 52276 and MON 76473 both activated oxidative stress and unfolded protein response. Negative; MON
Nagy et al 2021 [80]	GBH (Roundup Mega; Fozat 480 and Glyfos)	0.1, 1, 10, 100 µM	Human peripheral white blood cells	Cytokinesis-block micronucleus assay	**Positive**; GBH increased Mn frequency at all concentration.
Olah et al. 2022 [81]	GBH (Roundup classic)	10-6 -101 Roundup equivalent concentration	osteoblastic cell line (MC3T3-E1) and neuroectodermal stem cell-like (NE-4C)	Comet assay and Flow cytometry	**Positive**; marked DNA damage in exposed cells (comet assays; 5.5-fold, DNA damage kit 9-fold). Roundup classic > Glyphosate
Rice et al. 2018 [82]	GBHs	0.0007-33 mM	Human HepaRG and HaCaT cell lines	CellTiter-Glo, ROS-Glo, and JC10	**Positive**, oxidative stress (pure glyphosate ≥ 10 mM, formulations all conc.)
Rossi et al. 2018 [71]	GBH (Roundup Full II®)	0.026 -0.379 mL/day	Armadillo	Chromosomal aberrations	**Positive** (all conc.)
Wozniak et al. 2018 [88]	GBH (Roundup 360 PLUS®)	1 to 1000 µM	Human peripheral blood mononuclear cells	Breaks in peripheral mononuclear cells	**Positive**, DNA damage (GBH ≥ 5 µM)
Glyphosate Technical**				**Number of Assays**	**19**
				Positive	**13**
				Percent Positive	**68%**
Formulated GBHs**				**Number of Assays**	**12**
				Positive	**12**
				Percent Positive	**100%**
All New Studies				**Number of Assays**	**31**
				Positive	**25**
				Percent Positive	**81%**

* Final PubMed literature search performed on 04/10/2022.

**Some studies included assays on both glyphosate technical and formulated GBHs, the results of which are reported separately in this and other tables. For this reason, the number of assay results on glyphosate technical and/or formulated GBHs exceeds the total number of new studies.

*** Some studies report results of multiple assays. The "Results" column reports major results by assay type. "Positive" assays include those for which one or more positive response is reported. The evaluation of whether an assay is "Positive" or "Negative" is indicated in bold.

Supplemental Table S3. Non-mammalian *In Vivo* Studies Published Since the EPA and IARC Reviews of Glyphosate and Formulated GBH Genotoxicity*					
Citation [Reference Number from Benbrook et al., 2023]	**Compound Tested**	**Concentration(s)**	**Test Target**	**Assay**	**Result*** **
Non-mammalian *In Vivo*					
de Brito Rodrigues et al. 2019 [95]	Glyphosate technical	1.7, 5, 10, 23, 50 and 100 mg/L	zebrafish (*Danio rerio*)	Comet assay	**Positive**; all induced DNA damage
Giommi et al. 2022 [96]	Glyphosate technical	700 µg/L	male and female adult zebrafish	Oxidative stress	**Positive**; an impaired oxidative stress response and gene alterations in both sexes
Hong et al. 2017 [97]	Glyphosate technical	0, 4.4, 9.8, 44 and 98 mg/L	*Eriocheir sinensis* (crab)	Haemocyte DNA damage	**Positive** (> 4.4 mg/L)
Lopes et al. 2021 [98]	Glyphosate technical	65, 130, 260 and 520 µg/L	*Dendropsophus minutus* tadpoles	Alkaline comet assay	**Positive** DNA damage was observed in all the comet assay parameters at the 520 µg/L concentration, but only in the % DNA in tail to the concentration of 260 µg/L, with a mean increase in the frequency of DNA damage of approximately 165 % in comparison with the control.
Marçal et al. 2020 [99]	Glyphosate technical	9 and 90 µg/L	red swamp crayfish (*Procambarus clarkii*) spermatozoa	Alkaline comet assay	**Positive**; Spermatozoa exposed to the higher concentration presented a significant increase (3-fold) of non-specific damage (GDI) in relation to the control group, as well as in relation to the lowest concentration (1.7-fold)
Zheng et al. 2021 [100]	Glyphosate technical	0.2, 0.8, 4 and 16 mg/L	Tilapia (*Oreochromis niloticu* s)	Oxidative stress	**Positive**; oxidative stress and gene alterations at 4 and/16 mg/L
Acar et al. 2021 [101]	GBH	5, 10, 20, 30, and 40 mg/L	Nile tilapia (*Oreochromis niloticus*)	Comet assay	**Positive**; a significant increase in DNA damage in dose dependent fashion
Akça et al. 2021 [102]	GBH	2.5, 5, 10 mg/L	Rainbow trout (*Oncorhynchus mykiss*)	comet assay	**Positive**; DNA fragmentation (% DNA in tail) in sperm cells was higher in a dose-dependent manner.
Aribisala et al. 2022 [103]	GBH (Force Up)	0.10 and 0.01 mg/L	*Oreochromis niloticus* (Nile Tilapia)	Micronucleus assay	**Positive**; MN cells were significantly higher in the erythrocytes of O. niloticus exposed to the lower (0.01 mg/L) concentration when compared to the higher (0.12 mg/L) concentration and control at days 14 and 28.
Ayanda et al. 2021 [104]	GBH (Roundup Original)	0.36, 0.48, 0.60, 0.72 and 0.84 mg/L glyphosate	juvenile African Catfish (*Clarias gariepinus*)	Comet assay	**Positive**; marked increase in DNA damage in concentration-dependent manner.
Baurand et al. 2015 [105]	GBH (Round Up Flash®)	15, 30, 50 and 70 mg/L glyphosate	Snail eggs	RAPD-HRS assay	**Positive**; RAPD-HRS revealed concentration-dependent modifications in profiles generated from 30 mg/L glyphosate.
Braz-Mota et al. 2015 [106]	GBH (Roundup Original)	10 and 15 mg/L	Juveniles of tambaqui (*Colossoma macropomum*)	Comet assay	**Positive**; significant DNA damage at both concentrations.
Burella et al. 2017 [107]	GBH (Roundup Full II)	750, 1250, 1750 lg/egg	*Caiman latirostris* eggs (South American caiman)	Comet assay	**Positive**; A statistically significant difference in DNA damage determined by the CA was found
Burella et al. 2018 [108]	GBH (Roundup®)	750, 1250, 1750 µg/egg	*Caiman latirostris* (reptile)	Comet, embryos	**Positive**, DNA damage (all conc.)
Carvalho et al. 2019 [109]	GBH (Credit®)	5 and 10% of LC5096 h (78.18 mg/L)	*Rhinella arenarum* tadpoles	Single-cell gel electrophoresis (SCGE) assay	**Positive**; increase in genetic damage index at both concentrations
Carvalho et al. 2020 [110]	GBH Credit®	4.58 and 9.17 mg/L	Fish (*Cnesterodon decemmaculatus*)	SCGE (comet) assay	**Positive**; DNA damage
da Silva et al. 2019 [111]	GBH (Roundup)	75% of LC50 (nominal concentration: 15 mg/L) established for C. macropomum in 96 h in four treatments; normoxia (N), hypoxia (H), RD plus normoxia (NRD), and RD plus hypoxia (HRD)	fish (*Colossoma macropomum*)	Comet assay	**Positive**; DNA damage increased in fish exposed to NRD in comparison with N. There was no difference in genetic damages between H group and HRD group. According to genetic damage index (GDI), DNA damage was higher in fish exposed to H than in fish exposed to N.
Dal Santo et al. 2018 [112]	GBH (Roundup Original®)	5.0 mg/L	zebrafish (*Danio rerio*)	Micronucleus assay	**Positive**; Micronucleus frequency significantly increased after 96 h of exposure
de Brito Rodrigues et al. 2019 [95]	GBH (Atanor 48 ATN)	1.7, 5, 10, 23, 50 and 100 mg/L	zebrafish (*Danio rerio*)	Comet assay	**Positive**; all induced DNA damage
de Melo et al. 2020 [113]	GBH (Roundup WG®)	0.0065, 0.065 and 0.28 mg of glyphosate/L	Male and females freshwater prawn (*Macrobrachium potiuna*)	Gene expression	**Positive**; Males had an under-expression of the studied genes, indicating an oxidative stress and possible accumulation of ROS in the hepatopancreas. In the opposite, females had an overexpression of the same genes, indicating a more robust antioxidant system.
de Moura et al. 2017 [114]	GBH (Roundup®)	Not provided in abstract.	*Leiarius marmoratusx/ Pseudoplatystoma reticulatum* (fish)	Micronucleus	**Positive** (≥ 1.357 mg/L)

Citation [Reference Number from Benbrook et al., 2023]	Compound Tested	Concentration(s)	Test Target	Assay	Result***
de Oliveira et al. 2019 [115]	GBH	11.7 µg/kg	Kidney and liver of Fish	Micronucleus (MN) assay	**Positive**; increased damage to renal DNA and hepatic tissue.
de Oliveira et al. 2020 [116]	GBH	65 and 6500 ppb	Amazonian turtles (*Podocnemis expansa*)	Micronucleus assay	**Positive**; MN formation, DNA damage
Herek et al. 2020 [117]	GBH (Roundup original)	(500, 700 and 1000 µg/L	Amphibian *Physalaemus cuvieri* and *Physalaemus gracilis*	Micronucleus (MN) assay	**Positive**; Glyphosate-based herbicide caused a dose-dependent micronuclei formation and several types of erythrocyte nuclear abnormalities in both Physalaemus species.
Hong et al. 2018 [118]	GBH (Roundup®)	0.35, 0.70, 1.40, 2.80 and 5.60 mg/L	*Macrobrachium nipponensis* (shrimp)	Micronucleus	**Positive** (≥ 1.40 mg/L)
Khan et al. 2021 [119]	GBH (Roundup)	1, 2, 4, 6, 8, and 10 mM	*Vigna mungo* root meristem cells.	Chromosomal aberration assay	**Positive**; a dose-dependent reduction in the mitotic index and an increase in the percentage of chromosomal aberrations (CAs) and relative abnormality rate (RAR).
Lajmanovich et al. 2019 [120]	GBH (Roundup Ultra-Max®)	1.25, 2.5, 5, 10, 20, 40, and 80 mg/L	*Rhinella arenarum* tadpoles	Alkaline Comet assay	**Positive**; a mixture of roundup and arsenic induced DNA damage
Lopez Gonzalez et al. 2017 [121]	GBHs (Roundup Full II® and PanzerGold®)	500, 750, 1000 µg/egg	*Caiman latirostris* (reptile)	Micronucleus	**Positive**, embryos (≥ 1000 µg/egg)
Lopez Gonzalez et al. 2019 [122]	GBH (Roundup® Full II)	Concentration equivalent to application in soybean crops (2%/ha)	broad-snouted caiman (*Caiman latirostris*)	micronucleus (MN) assay	**Positive**; an increase in the frequency of buds and NN was observed in the mixture of Roundup and Cypermethrin
Lopez Gonzalez et al. 2022 [123]	GBH (Roundup® Full II)	2% (2 L/100 L H2O/ha)	broad-snouted caiman (*Caiman latirostris*)	comet assay (CA) and micronucleus (MN) assay	**Positive**; a statistically significant increase in MN and NAs frequency, DNA damage.
Martins et al. 2021 [124]	GBH (Roundup Transorb®)	2.07 and 3.68 mg/L	Silverside fish (*Odontesthes humensis*)	Flow cytometry analysis	**Positive**; both the concentrations of the herbicide induced a significant increase in the DNA fragmentation index (DFI) of erythrocytes.
Odetti et al. 2020 [125]	GBH (Roundup® Full II)	1 and 2 %	*Caiman latirostris*	Comet assay	**Positive**; significant DNA damage at both concentrations.
Pavan et al. 2021 [126]	GBH (Roundup Original)	65, 144, 280, 500, 1000 µg/L	*Boana faber* and *Leptodactylus latrans* tadpoles	Micronucleus (MN) assay	**Positive**; a mixture of glyphosate and 2,4-D induced micronuclei and other nuclear abnormalities in the erythrocytes
Pereira et al. 2018 [127]	GBH Stout	0.65, 1.0, 10 mg/L	*Danio rerio* (zebrafish)	Impacts on mitochondria and reactive oxygen formation	**Positive**, inhibited mitochondrial complex activity and RS production
Santovito et al. 2020 [128]	GBH (Roundup® Power)	1% Roundup® Power containing 3.6 g/L of glyphosate	Butterfly larvae (*Lycaena dispar*)	Micronucleus assay	**Positive**; exposure to Roundup® power induced, in L. dispar larvae, a significantly increased level of genomic damage, in terms of a higher frequency of MNi.
Schaumburg et al. 2016 [129]	GBH (Roundup®)	50, 100, 200, 400, 800, 1600 µg/egg	*Salvator merianae* (reptile)	Comet assay	**Positive**, DNA damage (≥ 100 µg/egg)
Soloneski et al. 2016 [130]	GBH (Credit®) and formulated dicamba herbicide (Banvel®)	5-10% formulation of GBHs	*Rhinella arenarum* larvae (amphibian)	SCGE	**Positive** for GBH alone, DNA breaks (above 5%)
Trigueiro et al. 2021 [131]	GBH (Roundup Original®)	65 and 130 µg of glyphosate/L equivalent to 0.18 and 0.36 µg/L of Roundup Original® respectively.	Guppy (*Poecilia reticulata*)	Comet assay	**Positive**; co-exposure of iron oxide nanoparticles with GBH induced DNA damage
Vieira et al. 2016 [132]	GBHs (*in situ* exposure)	Not provided in abstract.	*Prochilodus lineatus* (fish)	DNA damage, erythrocyte nuclear abnormalities	**Positive**
Glyphosate Technical**				**Number of Assays**	**6**
				Positive	**6**
				Percent Positive	**100%**
Formulated GBHs**				**Number of Assays**	**33**
				Positive	**33**
				Percent Positive	**100%**
All New Studies				**Number of Assays**	**39**
				Positive	**39**
				Percent Positive	**100%**

* Final PubMed literature search performed on 04/10/2022.

**Some studies included assays on both glyphosate technical and formulated GBHs, the results of which are reported separately in this and other tables. For this reason, the number of assay results on glyphosate technical and/or formulated GBHs exceeds the total number of new studies.

*** Some studies report results of multiple assays. The "Results" column reports major results by assay type. "Positive" assays include those for which one or more positive response is reported. The evaluation of whether an assay is "Positive" or "Negative" is indicated in bold.

Supplemental Table S4. Non-mammalian *In Vitro* Studies Published Since the EPA and IARC Reviews of Glyphosate and Formulated GBH Genotoxicity*

Citation [Reference Number from Benbrook et al., 2023]	Compound Tested	Concentration(s)	Test Target	Assay	Result***
Non-mammalian *In Vitro*					
Congur, 2021 [133]	Glyphosate technical	100 µL of 25-150 µg/mL	Double stranded fish sperm DNA	Voltametric detection using disposable pencil graphite electrodes (PGEs).	**Negative**; Glyphosate has negative effect onto double stranded DNA by using it alone or in combination with 2,4-D.
da Silva et al. 2020 [134]	Glyphosate technical	10 and 3.6 mg/L	zebrafish liver cell line (ZFL)	Comet assay	**Negative**; no alteration in DNA score was observed When the ZFL line was exposed to glyphosate alone.
Perez-Iglesias et al. 2016 [135]	Glyphosate technical	100, 1000, and 10,000 µg/g	*Leptodactylus latinasus* (frog)	Hepatic elanomacrophages - erythrocyte nuclear abnormalities	**Positive** (all conc.)
Bailey et al. 2018 [136]	GBH (TouchDown®)	2.7%, 5.5%, or 9.8% glyphosate	*Caenorhabditis elegans* (nematode)	Mitochondrial chain complexes	**Positive**, oxidative stress (≥ 5.5%)
Bollani et al. 2018 [137]	GBHs (*in situ* exposure)	glyphosate ≤ 13.6 µg/L, AMPA ≤ 9.75 µg/L	*Allium cepa* (plant)	Micronucleus	**Positive**
da Silva et al. 2020 [134]	GBH (Roundup Original)	10 and 3.6 mg/L	zebrafish liver cell line (ZFL)	Comet assay	**Positive**; Roundup® resulted in a significant increase in the DNA damage score
de Brito Rodrigues et al. 2017 [138]	GBHs (Roundup® and Glyphosate AKB 480)	Low doses not specified, high doses up to 37.53 mg/L	*Danio rerio* (fish)	Genotoxicity	**Negative** (lethal at high doses but no genotoxicity observed)
Santo et al. 2018 [112]	GBH (Roundup®)	5.0 mg/L	*Danio rerio* (fish)	Micronucleus	**Positive**, oxidative stress
Glyphosate Technical**				**Number of Assays**	**3**
				Positive	**1**
				Percent Positive	**33%**
Formulated GBHs**				**Number of Assays**	**5**
				Positive	**4**
				Percent Positive	**80%**
All New Studies				**Number of Assays**	**8**
				Positive	**5**
				Percent Positive	**63%**

* Final PubMed literature search performed on 04/10/2022.

**Some studies included assays on both glyphosate technical and formulated GBHs, the results of which are reported separately in this and other tables. For this reason, the number of assay results on glyphosate technical and/or formulated GBHs exceeds the total number of new studies.

*** Some studies report results of multiple assays. The "Results" column reports major results by assay type. "Positive" assays include those for which one or more positive response is reported. The evaluation of whether an assay is "Positive" or "Negative" is indicated in bold.

Supplemental Table S5. Studies Published Since the EPA and IARC Reviews of Glyphosate and Formulated GBH Genotoxicity* (see notes)					
Citation [Reference Number from Benbrook et al., 2023]	**Compound Tested**	**Concentration(s)**	**Test Target**	**Assay**	**Result*****
		Mammalian *In Vivo*			
Kasuba et al. 2017 [59]	Glyphosate technical	0.5, 2.91, and 3.5 µg/mL	Human	CBMN	**Positive.** Oxidative stress (all conc.)
Larsen et al. 2022 [60]	Glyphosate technical	20 and 200 ppm	Pigs	DNA methylation	**Negative**; no significant changes in global DNA methylation in small intestines, kidneys or livers. However, differences in the absolute value of global DNA methylation were seen between the three organs. Whereas DNA methylation rates were around 1% (0.8%–1.2%) in the small intestines and kidney tissues, a higher value of around 3% was observed in liver tissue
Mesnage et al 2022[61]	Glyphosate technical	50 mg/kg bw/day glyphosate	Liver and kidney of female Sprague Dawley rat	Aprurini/apyrimidinic site formation	**Negative**
Milic et al. 2018 [62]	Glyphosate technical	0.1, 0.5, 1.75, and 10 mg/kg/day	Wistar rat	Comet assay	**Positive**, DNA damage in leukocytes and liver cells (all conc.)
Tarboush et al. 2022 [63]	Glyphosate technical	20, 40, 200 µmol/L	Human Lymphocytes	Sister-chromatid exchange assay Chromosomal aberration assay 8-OHdG assay	**Positive**; glyphosate induced significant slight increases in the levels of SCE only at the highest concentration (200 µmol/L) Negative, Chromosomal aberration assay, no significant changes in CA were detected at all concentrations Negative; Glyphosate did not cause any changes in the level of 8-OHdG at all concentrations.
Avdatek et al. 2018 [64]	GBH (Knockdown 48 SL)	375 mg/kg/day	Wistar Albino rats	Single cell gel electrophoresis (comet) assay	**Positive**; High levels of DNA damage were detected .
de Maria Serra et al. 2022 [65]	GBH (Roundup® Original)	3.71 × 10−3, 6.19 × 10−3 and 9.28 × 10−3 grams of active ingredient per hectare (g.a.i./ha),	Male and female Wistar rats	Bone marrow micronucleus assay	**Positive**; a greater number of micronuclei were detected in females exposed to the low oral concentration, and the number was higher in males exposed to the high inhalation concentration.
Hutter et al. 2018 [66]	GBH	Unknown applicator exposure	Human	Micronucleus (MN) assay	**Positive**
Kupske et al. 2021 [67]	GBH	Unknown applicator exposure	Human	Micronucleus (MN) assay	**Positive**
Leite et al. 2019 [68]	GBH	Unknown children exposure	Human	Micronucleus (MN) assay	**Positive**
Lucia et al. 2022 [69]	GBH	0:12 - 1:65 ng/mL	postmenopausal women	DNA methylation	**Positive**. Roundup exposure was associated with DNA methylation differences that could promote the development of cancer and other diseases.
Makris et al. 2022 [70]	GBH	0.10, 0.29 µg/L	Human	Immunoassay	Negative for glyphosate, **Positive** for AMPA. Significant association was observed between AMPA and DNA oxidative damage marker (8-OHdG).
Mesnage et al 2022 [61]	GBH [MON 52276 (Roundup Bio Flow)]	50 mg/kg bw/day glyphosate	Liver and kidney of female Sprague Dawley rat	Aprurini/apyrimidinic site formation	**Positive**; MON 52276 induced more apurinic/ apyrimidinic DNA damage formation in liver than glyphosate.
Rossi et al. 2018 [71]	GBH (Roundup® Full II)	0.260, 0.053, 0.106, 0.379 mL	Armadillo (*Chaetophractus villosus*)	Chromosomal aberration	**Positive**; significant changes in sister chromatid exchange (SCE) at all concentrations.
Schnabel et al, 2020 [72]	GBH (Roundup record)	122.7 µg glyphosate/kg BW	Lactating German Holstein dairy cows	Comet assay	**Negative**; no genotoxic effects probably due to exposure that was 20 to 12,711 times lower compared to the discussed studies showing genotoxic effect
Soudani et al. 2019 [73]	GBH	50 mg/kg b.w	Albino rats	Comet assay	**Positive**; the herbicide induced oxidative DNA damage
		Mammalian *In Vitro*			
Alvarez-Moya et al. 2022 [74]	Glyphosate technical	0.07, 0.7 and 7 (human lymphocytes); 0.03, 0.05 and 0.07 (Ambystoma mexicanum and Oreochromis niloticus erythrocytes) mM.	erythrocytes of *Oreochromis niloticus* , *Ambystoma mexicanum* and human lymphocytes.	Comet assay	**Positive**; The 0.03, 0.05 and 0.07 mM concentrations of glyphosate induced significant genotoxic activity in human lymphocytes and in erythrocytes of the species studied.
Anifandis et al. 2018 [75]	Glyphosate technical	0.36 mg/L glyphosate	Human semen	Halosperm® G2 Kit.	**Negative**; glyphosate exerts toxic effects on sperm progressive motility but not on sperm DNA integrity
Barron Cuenca et al. 2022 [76]	Glyphosate technical	0.001, 0.01, 0.07 mM	Human liver HepG2 cells	Comet assay	**Negative**; no DNA damage. But a mixture of glyphosate, paraquat and cypermethrine induce DNA damage
Hao et al. 2020 [77]	Glyphosate technical	100 µg/mL	Human alveolar carcinoma A549 cell line	comet assay (single-cell electrophoresis assay)	**Negative**; Glyphosate alone did not induce oxidative DNA damage in the A549 cells.
Kasuba et al. 2017 [59]	Glyphosate technical	0.5, 2.91, and 3.5 µg/mL	Human HepG2 cells	Cytokinesis-block micronucleus (CBMN) cytome assay	**Positive**; a significantly higher number of MN and nuclear buds indicating DNA damage at 0.5 and 2.91 µg/mL
Kwiatkowska et al. 2017 [78]	Glyphosate technical	0.1-10 mM	Human peripheral blood mononuclear cells	Comet assay	**Positive**, DNA damage (at 0.5-10 mM doses)
Mesnage et al 2022 [61]	Glyphosate technical	500, 1000, 1500, 2000 and 2500 µM	Mouse embryonic stem (mEs) reporter cell line	ToxTracker Assay	**Negative**

Citation [Reference Number from Benbrook et al., 2023]	Compound Tested	Concentration(s)	Test Target	Assay	Result***
Mesnage et al. 2022 [79]	Glyphosate technical	1000, 2000, 3000, 4000 and 5000 µM	Human intestinal epithelial Caco-2 and hepatocyte HepG2 cell lines	ToxTracker assay	**Positive**; glyphosate induced oxidative stress in HepG2 cells.
Milic et al. 2018 [62]	Glyphosate technical	0.1 mg/kg bw/ day (AOEL), 0.5 mg/kg bw/day (ADI), 1.75 mg/kg bw/day (cPAD), and 10 mg/kg bw per day (100xAOEL).	leukocytes and liver tissue of Wistar rats	Alkaline comet assay	**Positive**; all treatments (mostly at 0.1 and 10 mg/kgbw/day) resulted in significantly higher primary DNA damage in the liver cells and leukocytes.
Nagy et al 2021 [80]	Glyphosate technical	0.1, 1, 10, 100 µM	Human peripheral white blood cells	Cytokinesis-block micronucleus assay	**Positive**; Glyphosate increased MN frequency only at 100 µM
Olah et al. 2022 [81]	Glyphosate Technical	10-6 -101 Roundup equivalent concentration	osteoblastic cell line (MC3T3-E1) and neuroectodermal stem cell-like (NE-4C)	Comet assay and Flow cytometry	**Positive**; marked DNA damage in exposed cells
Rice et al. 2018 [82]	Glyphosate technical	0.0007-33 mM	Human HepaRG and HaCaT cell lines	CellTiter-Glo, ROS-Glo, and JC10	**Positive**, oxidative stress (pure glyphosate ≥ 10 mM, formulations all conc.)
Santovito et al. 2018 [83]	Glyphosate technical	0.500, 0.100, 0.050, 0.025, and 0.0125 µg/mL	Human lymphocytes	Chromosomal aberration, micronuclei	**Positive**; chromosomal aberration (CA) and micronuclei (MNi) frequencies significantly increased at all tested
Suárez-Larios et al. 2017 [84]	Glyphosate technical	0, 0.4, 2, 10, 50 µM	Human lymphocytes	Immunofluorescence detection of Phosphorylated histone H2AX foci	**Positive**; glyphosate induced double-strand breaks (DSB) and a significant increase of p-Ku80 protein.
Szepanowski et al. 2018 [85]	Glyphosate technical	0.0005-0.005% of culture medium	Human dorsal root ganglia cultures	Mylenation	**Negative**
Townsend et al. 2017 [86]	Glyphosate technical	0.1 µM - 15 mM	Human Raji cells	Comet assay	**Positive**; glyphosate treatment is lethal to Raji cells at concentrations above 10mM, yet has no cytotoxic effects at concentrations at or below 100µM. concentrations of 1mM and 5mM induce statistically
Wozniak et al. 2018 [87]	Glyphosate technical and AMPA	1 to 1000 µM	Human peripheral blood mononuclear cells	Breaks in peripheral mononuclear cells	**Positive**, DNA damage (glyphosate ≥ 250 µM, AMPA ≥ 500 µM)
Wozniak et al. 2021 [88]	Glyphosate technical and AMPA	Glyphosate (0.5 to 100 µM); AMPA (0.5, to 250 µM)	human peripheral blood mononuclear cells (PBMCs)	Gene profiling	**Positive**; glyphosate changed the expression of DNMT1, DMNT3A, and HDAC3, while AMPA changed the expression of DNMT1 and HDAC3. The results also revealed that glyphosate at lower concentrations than
Zhang et al. 2019 [89]	Glyphosate technical	500 µM Glyphosate	Mouse Oocytes	Comet assay	**Negative**; no DNA damage but increased oxidative stress.
Bhardwaj et al. 2019 [90]	GBH	0.1, 2.0, and 4.0 mg/ml	granulosa cells of goat	EB/AO differential staining-fluorescence assay	**Positive**; increase in the incidence of apoptotic attributes within granulosa cells as well as oxidative stress with increasing dose and duration of the GBH treatment.
De Almeida et al. 2018 [91]	GBHs (Roundup® and Wipeout®)	10-500 µg/mL	Human cancer cells (the estrogen-E2-responsive HEC1A, MCF7 and the estrogen-insensitive MDA-MB-231)	Comet assay	**Positive** At 500 µg/ml, glyphosate demonstrated DNA damage in the HEC1A and MDA-MB-231 cells. Adjuvants and/or glyphosate impurities were potential contributing factors of toxicity based on the differential toxicities displayed by Roundup and Wipeout in human whole blood and the HEC1A cells.
Hao et al. 2019 [92]	GBH (Roundup)	50, 75, 100 and 125 mg/mL	Human alveolar carcinoma cells (A549 cells).	Alkaline comet assay	**Positive**; Roundup caused concentration dependent increases in DNA damages and proportion of apoptotic cells in A549 cells.
Hao et al. 2020 [77]	GBH (Roundup)	100 µg/mL	Human alveolar carcinoma A549 cell line	comet assay (single-cell electrophoresis assay)	**Positive**; oxidative DNA damage, DNA single-strand breaks and double-strand breaks are occurred in Roundup and POEA treated A549 cells.
Luaces et al. 2017 [93]	GBH (Roundup Full II®)	280, 420, 560, 1120 µmol/L	Peripheral blood lymphocytes of Armadillo (*Chaetophractus villosus*)	Chromosomal aberration (CA) and sister chromatid exchanges (SCE) assay	**Positive**; Significant increases seen in the CA frequency and the mean number of SCEs per cell at all concentrations tested.
Luo et al. 2017 [94]	GBH (Roundup®)	60 to 180 mg/L Roundup	Human	L-02 hepatocytes	**Positive**, oxidative stress
Mesnage et al. 2022 [79]	GBH (RangerPro, POE-15)	1000, 2000, 3000, 4000 and 5000 µM	Human intestinal epithelial Caco-2 and hepatocyte HepG2 cell lines	ToxTracker assay	**Positive**; RangerPro was ~22 times and POE-15 > 3000 times more cytotoxic than glyphosate, which was not.
Nagy et al 2021 [80]	GBH (Roundup Mega; Fozat 480 and Glyfos)	0.1, 1, 10, 100 µM	Human peripheral white blood cells	Cytokinesis-block micronucleus assay	**Positive**; GBH increased Mn frequency at all concentration.
Olah et al. 2022 [81]	GBH (Roundup classic)	10-6 -101 Roundup equivalent concentration	osteoblastic cell line (MC3T3-E1) and neuroectodermal stem cell-like (NE-4C)	Comet assay and Flow cytometry	**Positive**; marked DNA damage in exposed cells (comet assays; 5.5-fold, DNA damage kit 9-fold). Roundup classic > Glyphosate
Rice et al. 2018 [82]	GBHs	0.0007-33 mM	Human HepaRG and HaCaT cell lines	CellTiter-Glo, ROS-Glo, and JC10	**Positive**, oxidative stress (pure glyphosate ≥ 10 mM, formulations all conc.)
Rossi et al. 2018 [71]	GBH (Roundup Full II®)	0.026 -0.379 mL/day	Armadillo	Chromosomal aberrations	**Positive** (all conc.)
Wozniak et al. 2018 [88]	GBH (Roundup 360 PLUS®)	1 to 1000 µM	Human peripheral blood mononuclear cells	Breaks in peripheral mononuclear cells	**Positive**, DNA damage (GBH ≥ 5 µM)
Non-mammalian *In Vivo*					
de Brito Rodrigues et al. 2019 [95]	Glyphosate technical	1.7, 5, 10, 23, 50 and 100 mg/L	zebrafish (*Danio rerio*)	Comet assay	**Positive**; all induced DNA damage

Citation [Reference Number from Benbrook et al., 2023]	Compound Tested	Concentration(s)	Test Target	Assay	Result***
Giommi et al. 2022 [96]	Glyphosate technical	700 µg/L	male and female adult zebrafish	Transcript analysis of genes	**Positive**; an impaired oxidative stress response and gene alterations in both sexes
Hong et al. 2017 [97]	Glyphosate technical	0, 4.4, 9.8, 44 and 98 mg/L	*Eriocheir sinensis* (crab)	Haemocyte DNA damage	**Positive** (> 4.4 mg/L)
Lopes et al. 2021 [98]	Glyphosate technical	65, 130, 260 and 520 µg/L	*Dendropsophus minutus* tadpoles	Alkaline comet assay	**Positive** DNA damage was observed in all the comet assay parameters at the 520 µg/L concentration, but only in the % DNA in tail to the concentration of 260 µg/L, with a mean increase in the frequency of DNA damage of approximately 165 % in comparison with the control.
Marçal et al. 2020 [99]	Glyphosate technical	9 and 90 µg/L	red swamp crayfish (*Procambarus clarkii*) spermatozoa	Alkaline comet assay	**Positive**; Spermatozoa exposed to the higher concentration presented a significant increase (3-fold) of non-specific damage (GDI) in relation to the control group, as well as in relation to the lowest concentration (1.7-fold)
Zheng et al. 2021 [100]	Glyphosate technical	0.2, 0.8, 4 and 16 mg/L	Tilapia (*Oreochromis niloticus*)	Gene expression	**Positive**; oxidative stress and gene alterations at 4 and/16 mg/L
Acar et al. 2021 [101]	GBH	5, 10, 20, 30, and 40 mg/L	Nile tilapia (*Oreochromis niloticus*)	Comet assay	**Positive**; a significant increase in DNA damage in dose dependent fashion
Akça et al. 2021 [102]	GBH	2.5, 5, 10 mg/L	Rainbow trout (*Oncorhynchus mykiss*)	comet assay	**Positive**; DNA fragmentation (% DNA in tail) in sperm cells was higher in a dose-dependent manner.
Aribisala et al. 2022 [103]	GBH (Force Up)	0.10 and 0.01 mg/L	*Oreochromis niloticus* (Nile Tilapia)	Micronucleus assay	**Positive**; MN cells were significantly higher in the erythrocytes of O. niloticus exposed to the lower (0.01 mg/L) concentration when compared to the higher (0.12 mg/L) concentration and control at days 14 and 28.
Ayanda et al. 2021 [104]	GBH (Roundup Original)	0.36, 0.48, 0.60, 0.72 and 0.84 mg/L glyphosate	juvenile African Catfish (*Clarias gariepinus*)	Comet assay	**Positive**; marked increase in DNA damage in concentration-dependent manner.
Baurand et al. 2015 [105]	GBH (Round Up Flash®)	15, 30, 50 and 70 mg/L glyphosate	Snail eggs	RAPD-HRS assay	**Positive**; RAPD-HRS revealed concentration-dependent modifications in profiles generated from 30 mg/L glyphosate.
Braz-Mota et al. 2015 [106]	GBH (Roundup Original)	10 and 15 mg/L	Juveniles of tambaqui (*Colossoma macropomum*)	Comet assay	**Positive**; significant DNA damage at both concentrations.
Burella et al. 2017 [107]	GBH (Roundup Full II)	750, 1250, 1750 lg/egg	*Caiman latirostris* eggs (South American caiman)	Comet assay	**Positive**; A statistically significant difference in DNA damage determined by the CA was found
Burella et al. 2018 [108]	GBH (Roundup®)	750, 1250, 1750 µg/egg	*Caiman latirostris* (reptile)	Comet, embryos	**Positive**, DNA damage (all conc.)
Carvalho et al. 2019 [109]	GBH (Credit®)	5 and 10% of LC5096 h (78.18 mg/L)	*Rhinella arenarum* tadpoles	Single-cell gel electrophoresis (SCGE) assay	**Positive**; increase in genetic damage index at both concentrations
Carvalho et al. 2020 [110]	GBH Credit®	4.58 and 9.17 mg/L	Fish (*Cnesterodon decemmaculatus*)	SCGE (comet) assay	**Positive**; DNA damage
da Silva et al. 2019 [111]	GBH (Roundup)	75% of LC50 (nominal concentration: 15 mg/L) established for C. macropomum in 96 h in four treatments; normoxia (N), hypoxia (H), RD plus normoxia (NRD), and RD plus hypoxia (HRD)	fish (*Colossoma macropomum*)	Comet assay	**Positive**; DNA damage increased in fish exposed to NRD in comparison with N. There was no difference in genetic damages between H group and HRD group. According to genetic damage index (GDI), DNA damage was higher in fish exposed to H than in fish exposed to N.
Dal Santo et al. 2018 [112]	GBH (Roundup Original®)	5.0 mg/L	zebrafish (*Danio rerio*)	Micronucleus assay	**Positive**; Micronucleus frequency significantly increased after 96 h of exposure
de Brito Rodrigues et al. 2019 [95]	GBH (Atanor 48 ATN)	1.7, 5, 10, 23, 50 and 100 mg/L	zebrafish (*Danio rerio*)	Comet assay	**Positive**; all induced DNA damage
de Melo et al. 2020 [113]	GBH (Roundup WG®)	0.0065, 0.065 and 0.28 mg of glyphosate/L	Male and females freshwater prawn (*Macrobrachium potiuna*)	Gene expression	**Positive**; Males had an under-expression of the studied genes, indicating an oxidative stress and possible accumulation of ROS in the hepatopancreas. In the opposite, females had an overexpression of the same genes, indicating a more robust antioxidant system.
de Moura et al. 2017 [114]	GBH (Roundup®)	Not provided in abstract.	*Leiarius marmoratusx/ Pseudoplatystoma reticulatum* (fish)	Micronucleus	**Positive** (≥ 1.357 mg/L)
de Oliveira et al. 2019 [115]	GBH	11.7 µg/kg	Kidney and liver of Fish	Micronucleus (MN) assay	**Positive**; increased damage to renal DNA and hepatic tissue.
de Oliveira et al. 2020 [116]	GBH	65 and 6500 ppb	Amazonian turtles (*Podocnemis expansa*)	Micronucleus assay	**Positive**; MN formation, DNA damage
Herek et al. 2020 [117]	GBH (Roundup original)	(500, 700 and 1000 µg/L	Amphibian *Physalaemus cuvieri* and *Physalaemus gracilis*	Micronucleus (MN) assay	**Positive**; Glyphosate-based herbicide caused a dose-dependent micronuclei formation and several types of erythrocyte nuclear abnormalities in both Physalaemus species.
Hong et al. 2018 [118]	GBH (Roundup®)	0.35, 0.70, 1.40, 2.80 and 5.60 mg/L	*Macrobrachium nipponensis* (shrimp)	Micronucleus	**Positive** (≥ 1.40 mg/L)
Khan et al. 2021 [119]	GBH (Roundup)	1, 2, 4, 6, 8, and 10 mM	*Vigna mungo* root meristem cells.	Chromosomal aberration assay	**Positive**; a dose-dependent reduction in the mitotic index and an increase in the percentage of chromosomal aberrations (CAs) and relative abnormality rate (RAR).
Lajmanovich et al. 2019 [120]	GBH (Roundup Ultra-Max®)	1.25, 2.5, 5, 10, 20, 40, and 80 mg/L	*Rhinella arenarum* tadpoles	Alkaline Comet assay	**Positive**; a mixture of roundup and arsenic induced DNA damage

Citation [Reference Number from Benbrook et al., 2023]	Compound Tested	Concentration(s)	Test Target	Assay	Result***
Lopez Gonzalez et al. 2017 [121]	GBHs (Roundup Full II® and PanzerGold®)	500, 750, 1000 µg/egg	*Caiman latirostris* (reptile)	Micronucleus	**Positive**, embryos (≥ 1000 µg/egg)
Lopez Gonzalez et al. 2019 [122]	GBH (Roundup® Full II)	Concentration equivalent to application in soybean crops (2%/ha)	broad-snouted caiman (*Caiman latirostris*)	micronucleus (MN) assay	**Positive**; an increase in the frequency of buds and NN was observed in the mixture of Roundup and Cypermethrin
Lopez Gonzalez et al. 2022 [123]	GBH (Roundup® Full II)	2% (2 L/100 L H2O/ha)	broad-snouted caiman (*Caiman latirostris*)	comet assay (CA) and micronucleus (MN) assay	**Positive**; a statistically significant increase in MN and NAs frequency, DNA damage.
Martins et al. 2021 [124]	GBH (Roundup Transorb®)	2.07 and 3.68 mg/L	Silverside fish (*Odontesthes humensis*)	Flow cytometry analysis	**Positive**; both the concentrations of the herbicide induced a significant increase in the DNA fragmentation index (DFI) of erythrocytes.
Odetti et al. 2020 [125]	GBH (Roundup® Full II)	1 and 2 %	*Caiman latirostris*	Comet assay	**Positive**; significant DNA damage at both concentrations.
Pavan et al. 2021 [126]	GBH (Roundup Original)	65, 144, 280, 500, 1000 µg/L	*Boana faber* and *Leptodactylus latrans* tadpoles	Micronucleus (MN) assay	**Positive**; a mixture of glyphosate and 2,4-D induced micronuclei and other nuclear abnormalities in the erythrocytes
Pereira et al. 2018 [127]	GBH Stout	0.65, 1.0, 10 mg/L	*Danio rerio* (zebrafish)	Impacts on mitochondria and reactive oxygen formation	**Positive**, inhibited mitochondrial complex activity and RS production
Santovito et al. 2020 [128]	GBH (Roundup® Power)	1% Roundup® Power containing 3.6 g/L of glyphosate	Butterfly larvae (*Lycaena dispar*)	Micronucleus assay	**Positive**; exposure to Roundup® power induced, in L. dispar larvae, a significantly increased level of genomic damage, in terms of a higher frequency of MNi.
Schaumburg et al. 2016 [129]	GBH (Roundup®)	50, 100, 200, 400, 800, 1600 µg/egg	*Salvator merianae* (reptile)	Comet assay	**Positive**, DNA damage (≥ 100 µg/egg)
Soloneski et al. 2016 [130]	GBH (Credit®) and formulated dicamba herbicide (Banvel®)	5-10% formulation of GBHs	*Rhinella arenarum* larvae (amphibian)	SCGE	**Positive** for GBH alone, DNA breaks (above 5%)
Trigueiro et al. 2021 [131]	GBH (Roundup Original®)	65 and 130 µg of glyphosate/L equivalent to 0.18 and 0.36 µg/L of Roundup Original® respectively.	Guppy (*Poecilia reticulata*)	Comet assay	**Positive**; co-exposure of iron oxide nanoparticles with GBH induced DNA damage
Vieira et al. 2016 [132]	GBHs (*in situ* exposure)	Not provided in abstract.	*Prochilodus lineatus* (fish)	DNA damage, erythrocyte nuclear abnormalities	**Positive**
Non-mammalian *In Vitro*					
Congur, 2021 [133]	Glyphosate Technical	100 µL of 25-150 µg/mL	Double stranded fish sperm DNA	Voltametric detection using disposable pencil graphite electrodes (PGEs).	**Negative**; Glyphosate has negative effect onto double stranded DNA by using it alone or in combination with 2,4-D.
da Silva et al. 2020 [134]	Glyphosate technical	10 and 3.6 mg/L	zebrafish liver cell line (ZFL)	Comet assay	**Negative**; no alteration in DNA score was observed When the ZFL line was exposed to glyphosate alone.
Perez-Iglesias et al. 2016 [135]	Glyphosate technical	100, 1000, and 10,000 µg/g	*Leptodactylus latinasus* (frog)	Hepatic elanomacrophages - erythrocyte nuclear abnormalities	**Positive** (all conc.)
Bailey et al. 2018 [136]	GBH (TouchDown®)	2.7%, 5.5%, or 9.8% glyphosate	*Caenorhabditis elegans* (nematode)	Mitochondrial chain complexes	**Positive**, oxidative stress (≥ 5.5%)
Bollani et al. 2018 [137]	GBHs (*in situ* exposure)	glyphosate ≤ 13.6 µg/L, AMPA ≤ 9.75 µg/L	*Allium cepa* (plant)	Micronucleus	**Positive**
da Silva et al. 2020 [134]	GBH (Roundup Original)	10 and 3.6 mg/L	zebrafish liver cell line (ZFL)	Comet assay	**Positive**; Roundup® resulted in a significant increase in the DNA damage score
de Brito Rodrigues et al. 2017 [138]	GBHs (Roundup® and Glyphosate AKB 480)	Low doses not specified, high doses up to 37.53 mg/L	*Danio rerio* (fish)	Genotoxicity	**Negative** (lethal at high doses but no genotoxicity observed)
Santo et al. 2018 [112]	GBH (Roundup®)	5.0 mg/L	*Danio rerio* (fish)	Micronucleus	**Positive**, oxidative stress
Glyphosate Technical**				**Number of Assays**	**33**
				Positive	**24**
				Percent Positive	**73%**
Formulated GBHs**				**Number of Assays**	**61**
				Positive	**58**
				Percent Positive	**95%**
All New Studies				**Number of Assays**	**94**
				Positive	**82**
				Percent Positive	**87%**

* Final PubMed literature search performed on 04/10/2022.

**Some studies included assays on both glyphosate technical and formulated GBHs, the results of which are reported separately in this and other tables. For this reason, the number of assay results on glyphosate technical and/or formulated GBHs exceeds the total number of new studies.

*** Some studies report results of multiple assays. The "Results" column reports major results by assay type. "Positive" assays include those for which one or more positive response is reported. The evaluation of whether an assay is "Positive" or "Negative" is indicated in bold.

Supplemental Table S6. OPP/EPA Evaluation of Glyphosate Genotoxicity Studies Referenced in the Glyphosate Oncogenicity Issue Paper as Reviewed in the September 13, 2016 memo "Glyphosate. Study summaries for genotoxicity studies" (see [143] for full citations to the registrant and published studies included in this table)*

Citation	Organism	Assay	Author's Reported Result	OPP/EPA Comments
Registrant Commissioned Studies				
Akanuma (1995)		BRM	Negative	None
Collander (1996)		BRM	Negative	None
Durward (2006)	Mouse	MN	Negative	None
Flowers and Kier (1978)		BRM	Negative	None
Fox (1988)	Human lymphocytes	Cytogenetic	Negative	None
Fox and Mackay (1996)	Mouse	MN	Negative	None
Hornarvar (2008)	Mouse	MN	Negative	None
Jensen (1993a)		BRM	Negative	None
Jensen (1991b)	Mouse lymphoma cells	Gene mutation	Negative	None
Jensen (1991c)	Mouse	MN	Negative	None
Li (1983a)	Chinese hamster ovary	Gene mutation	Negative	None
Li (1983b)	Rat	Cytogenetic	Negative	None
Li and Long (1988)	Rat	UDS	Negative	None
Majeska (1982a)		BRM	Negative	None
Majeska (1982b)		Cell transformation	Negative	None
Majeska (1982c)	Rat	Chrom aberration	Negative	None
Majeska (1985a)		BRM	Negative	None
Majeska (1985b)	Mouse lymphoma cells	Forward mutation	Negative	None
Majeska (1985c)	Chinese hamster ovary cells	Chrom aberration	Negative	None
Majeska (1987)	CD1 mice	MN	Negative	None
Matsumoto (1995)	Chinese hamster lung cells	Chrom aberration	Negative	None
Ribeiro (2007)		BRM	Negative	None
Shirasu (1978)		Rec-assay	Negative	None
		BRM	Negative	None
Sokolowski (2007a)		BRM	Negative	None
Sokolowski (2007b)		BRM	Negative	None
Sokolowski (2007c)		BRM	Negative	None
Sokolowski (2009b)		BRM	Negative	None
Sokolowski (2010)		BRM	Negative	None
Suresh (1992)	Rat	Dominant lethal	Negative	None
Suresh (1993b)	Female mice	MN	Positive	None
	Male mice	MN	Negative	None
Suresh (1994)	Mice	Chrom aberration	Negative	None
Thompson (1996)		BRM	Negative	None
Wright (1996)	Chinese hamster ovary cells	Chrom aberration	Negative	None
Zaccaria (1996)	Mice	MN	Negative	None
Zoriki (1997)	Mice	MN	Negative	None
Published Studies				
Alvarez-Moya et al. (2014)	Human blood samples	Comet	Positive	Extreme caution: Use of finger stick instead of venipuncture; no data tail intensity
Bolognesi et al (1997)		SCE	Positive	Limited methods information; abnormally low SCE baseline; small number of animals in MN tests.
	CD1 mice	Multiple	Positive	
	CD1 mice	MN	Positive	
Chruscielska et al (2000)		BRM	Negative	None
	C3H	MN	Negative	None
Koller et al (2012)	Human carcinoma cells	Comet	Positive	Cell line not primary buccal cells; pH not monitored; limitations may impact significance of findings
	Human carcinoma cells	MN	Positive	
Loi et al (1998a)	Bovine lymphocyte culture	Chrom aberration	Positive	72 hr exposure too long for 1 round of mitosis; data pooled, no mean +/- SD; limitations lessen impact.
	Bovine lymphocyte culture	SCE	Positive	
Loi et al (1998b)	Human lymphocytes	CA	Positive	72 hr exposure too long; data pooled; no positive control; limitations may impact findings.
	Human lymphocytes	SCE	Positive	

Citation	Organism	Assay	Author's Reported Result	OPP/EPA Comments
Mañas (2009)	Hep-2 cells	Comet	Positive	Hep-2 cells not characterized re DNA damage response; MN slides maybe not coded/blind; limitations should be considered.
	Mice	MN	Positive	
	Human lymphocytes	Chrom aberration	Negative	None
Mañas (2013)	Mice	Comet	Positive	No positive control; biological significance of changes in tail intensity questionable.
	Mice	Oxidative stress	Positive	
Mladinic et al (2009a)	Human lymphocytes	MN	Positive	Deviation in protocol from OECD recommendation; question re slides blinded; caution should be used in interpreting results.
	Human lymphocytes	Comet	Positive	
Mladinic et al (2009b)	Human lymphocytes	MN FISH	Positive	72 hr exposure; caution should be taken when interpreting results.
Moriya (1983)		BRM	Negative	None
NTP (1992)		BRM	Negative	None
Piešová (2004)	Bovine lymphocytes	MN	Positive	Questions re pH and coding; limitations may impact results.
Peluso (1998)	CD1 mice	DNA adducts	Negative	None
Rank et al (1993)	Mice	MN	Negative	None
Roustan et al (2014)	Chinese hamster ovary cells	MN	Positive	None
Šiviková, and Dianovský (2006)	Bovine lymphocytes	Chrom aberration	Negative	Questions why 62% glyphosate was used; lack of clear dose response.
	Bovine lymphocytes	SCE	Positive	
Wilderman and Nazar (1982)		BRM in plant metabolism	Negative	

	Type	Number of Assays	Number Positive
Registrant Studies	BRM	14	0
	MN	9	1
	Gene mutations and other	9	0
	Chromosomal aberration	5	0
	Totals	37	1
	Percent Positive	**2.7%**	
	BRM as % All	**37.8%**	
	% Since 2000	**21.6%**	

	Type	Number of Assays	Number Positive
Published Studies	BRM	4	0
	MN	8	7
	SCE	4	4
	Comet	5	5
	Chromosomal aberration	4	2
	Oxidative stress & other	3	2
	Totals	28	20
	Percent Positive	**71.4%**	
	BRM as % All	**14.3%**	
	% Since 2000	**35.7%**	

Notes:

*Multiple studies reviewed by OPP/EPA reported assay results of tests using formulated GBHs. OPP/EPA largely ignored these results in its review of glyphosate genotoxicity.