

CometAssay[®] HT

Reagent Kit for
Higher Throughput Single Cell Gel
Electrophoresis Assay

Catalog # 4252-040-K

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I. Background

Trevigen's CometAssay[®], or single cell gel electrophoresis assay, provides a simple and effective method for evaluating DNA damage in cells. The principle of the assay is based upon the ability of denatured, cleaved DNA fragments to migrate out of the nucleoid under the influence of an electric field, whereas undamaged DNA migrates slower and remains within the confines of the nucleoid when a current is applied. Evaluation of the DNA "comet" tail shape and migration pattern allows for assessment of DNA damage. The Neutral CometAssay[®] is typically used to detect double-stranded breaks, whereas the Alkaline CometAssay[®] is more sensitive, and is used to detect smaller amounts of damage including single and double-stranded breaks.

Trevigen's CometAssay[®] HT uses our exclusive 20 well CometSlide™ that is specially treated to promote adherence of low melting point agarose. This eliminates the time consuming and unreliable traditional method of preparing base layers of agarose. The use of 20 well CometSlide™ (cat# 4252-040-01) shortens the overall assay time and allows for the rapid and reliable analysis of large numbers of samples.

In comet assays, cells are immobilized in a bed of low melting point agarose, on a Trevigen CometSlide™. Following gentle cell lysis, and for the Alkaline CometAssay[®], samples are treated with alkali to unwind and denature the DNA and hydrolyze sites of damage. For both assays, cells are lysed and the remaining nucleoids are subjected to electrophoresis and subsequent staining with a fluorescent DNA intercalating dye. Trevigen recommends using CometAssay[®] Control Cells (cat# 4256-010-CC) when performing alkaline electrophoresis, and Neutral CometAssay[®] Control Cells (cat# 4257-010-NC) when performing the neutral comet assay, to monitor assay conditions and verify reproducibility between separate runs. SYBR[®] Gold for DNA visualization by epifluorescence microscopy is recommended. As an alternative for researchers who do not have access to a fluorescence microscope, silver staining allows standard light microscopy for comet tail analysis.

We recommend the use of Trevigen's CometAssay[®] Electrophoresis System (cat# 4250-050-ES) designed to eliminate known causes of assay variability. The electrophoresis step is performed using an Alkaline Electrophoresis Solution pH>13, for the alkaline version, whereas a Neutral Electrophoresis Buffer is recommended for the neutral version. Quantitative and statistical data can readily be generated by analysis of the results using one of several commercially available image analysis software packages which calculate tail length, percent DNA in the tail, and tail moment.

The CometAssay[®] may be coupled with Trevigen's FLARE™ (Fragment Length Analysis using Repair Enzymes) Assay that provides the added ability to probe for specific types of DNA damage using DNA repair glycosylases. Contact Trevigen for more details about analysis of DNA damage and repair.

II. Precautions and Limitations

1. For Research Use Only. Not for use in diagnostic procedures.
2. The physical, chemical, and toxicological properties of the products contained within the CometAssay[®] Kit may not have been fully investigated. Therefore, Trevigen recommends the use of gloves, lab coats, and eye protection while using any of these chemical reagents. Trevigen assumes no liability for damage resulting from handling or contact with these products.
3. Lysis Solution contains 1% sodium lauryl sarcosinate which is an irritant and precipitates with long term storage at 4°C. In case of eye or skin contact, wash thoroughly under running water. In case of ingestion, rinse mouth with water and seek medical advice.
4. SYBR[®] Gold contains DMSO. Please refer to manufacturer.

III. Materials Supplied

Component	Catalog #	Amount	Storage
Lysis Solution	4250-010-01	100 ml	Room temp.
Comet LMAgarose (LMA)	4250-050-02	15 ml	4°C
CometAssay [®] HT Slide (20 well)	4252-040-01	2 each	Room temp.
200 mM EDTA, pH 10	4250-050-04	12.5 ml	Room temp.

IV. Materials/Equipment Required But Not Supplied

Equipment:

1. 1–20 µl, 20–200 µl, 200–1,000 µl pipettors, and tips
2. Serological pipettor and pipettes
3. Boiling water bath and 37°C water bath
4. CometAssay[®] Electrophoresis System (cat# 4250-050-ES)*
5. Epifluorescence microscope equipped with Fluorescein filter or light transmission microscope when using silver staining kit.
6. 1 L graduated cylinder
7. 4°C refrigerator/cold room
8. Staining Jars for 3' x 2' slide or other container, e.g., pipet box

Reagents:

1. Deionized water
2. 10X PBS, Ca⁺⁺ and Mg⁺⁺ free (cat# 4870-500)*
3. 95% Ethanol (reagent grade)
4. TE Buffer (10 mM Tris (pH 7.5), 1 mM EDTA)
5. 10,000X SYBR[®] Gold in DMSO (see Appendix C: *DNA Stains*)

For alkaline assays:

6. NaOH Pellets
7. 0.5 M EDTA (pH 8.0)

For neutral assays:

8. Tris Base
9. Ammonium Acetate
10. Sodium Acetate
11. Glacial Acetic Acid

Optional reagents:

12. Silver staining kit (cat# 4254-050-K)*
13. Dimethylsulfoxide

* Available from Trevigen.

V. Reagent Preparation

1. 1X PBS, Ca⁺⁺ and Mg⁺⁺ free

Dilute 10X PBS with deionized water to prepare 1X PBS and store at room temperature. (10X PBS is available from Trevigen, cat# 4870-500).

2. Lysis Solution

For 2 slides (20 samples per slide) prepare:

Lysis Solution (Cat # 4250-050-01)	50 ml
DMSO	5 ml (optional)

Cool to 4°C for at least 20 minutes before use. Slide is laid flat and sample areas covered with the Lysis Solution. The addition of DMSO is optional and is required only for samples containing heme, such as blood cells or tissue samples. The buffer formulation is proprietary.

3. Comet LMAgarose

The Comet LMAgarose is ready to use once molten. Loosen the cap to allow for expansion then heat the bottle in a 90–100°C water bath for 5 minutes, or until the agarose is molten (Caution: Microwaving is not recommended). Place the bottle in a 37°C water bath for at least 20 minutes to cool. The LMAgarose will remain molten at 37°C for sample preparation indefinitely. The LMAgarose formulation is proprietary.

4. SYBR[®] Gold Staining Solution (see Section IV: *Materials Not Supplied*)

The diluted stock is stable for several weeks when stored at 4°C in the dark.

10,000X SYBR [®] Gold in DMSO	1 µl
TE Buffer, pH 7.5	30 ml
(TE: 10 mM Tris-HCl pH 7.5, 1 mM EDTA)	

Note: Alternative dyes are described in Appendix C: *DNA Stains*.

5. Anti-fade Solution (optional)

Prepare if fading of samples occurs. In a 50 ml tube, mix until dissolved:

p-Phenylenediamine dihydrochloride	500 mg
1X PBS	4.5 ml

Add approximately 400 µl of 10 N NaOH drop wise with stirring until pH of solution reaches 7.5-8.0. Add 1X PBS to increase the volume to 5 ml, and 45 ml of glycerol for a final volume of 50 ml. Vortex mixture thoroughly and apply 10 µl per sample, covering samples with coverslip. Nail polish may be used to seal coverslip. Restaining of slides is not recommended. Anti-fade solution is stored at -20°C for one month. Darkening of solution may occur. Alternatively a fluorescent aqueous based mounting medium can be used (for example cat#4866-20).

For Alkaline Comet Assay:

6. Alkaline Unwinding Solution, pH>13 (200 mM NaOH, 1 mM EDTA)

Wear gloves when preparing and handling the Alkaline Unwinding Solution.

Per 50 ml of Alkaline Solution combine:

NaOH Pellets	0.4 g
200 mM EDTA (cat # 4250-050-04)	250 µl
dH ₂ O	49.75 ml

Stir until fully dissolved. The solution will warm during preparation. Allow to cool to room temperature before use.

7. Alkaline Electrophoresis Solution pH >13 (200 mM NaOH, 1 mM EDTA) for the CometAssay[®] ES system:

Prepare a stock solution of 500 mM EDTA, pH 8.

For 1 liter of electrophoresis solution:

NaOH pellets	8 g
500 mM EDTA, pH 8	2 ml
dH ₂ O (after NaOH is dissolved) add to:	1 liter

Use of freshly made solution is recommended. Cool to 4°C.

For Neutral Comet Assay:

8. 1X Neutral Electrophoresis Buffer

To prepare 10X **Neutral Electrophoresis Buffer**:

Tris Base (mol. wt. = 121.14)	60.57 g
Sodium Acetate (mol. wt. = 136.08)	204.12 g

Dissolve in 450 ml of dH₂O. Adjust to pH = 9.0 with glacial acetic acid. Adjust volume to 500 ml, filter sterilize and store at room temperature. Dilute the 10X stock to 1X in dH₂O to prepare 1 liter working strength buffer and cool to 4°C.

9. DNA Precipitation Solution

Prepare a 10 ml stock solution of 7.5M Ammonium Acetate:

NH ₄ Ac (mol. wt. = 77.08)	5.78 g
dH ₂ O (after NH ₄ Ac is dissolved) add to:	10 ml

For 50 ml of DNA precipitation solution combine:

7.5 M NH ₄ Ac (mol. wt. = 77.08)	6.7 ml
95% EtOH (reagent grade)	43.3 ml

VI. Sample Preparation and Storage

Cell samples should be prepared immediately before starting the assay, although success has been obtained using cryopreserved cells (see below). Cell samples should be handled under dimmed or yellow light to prevent DNA damage from ultraviolet light. Buffers should be cooled to 4°C to inhibit endogenous damage occurring during sample preparation and to inhibit repair in cells. PBS must be calcium and magnesium free to inhibit endonuclease activities. The appropriate controls should also be included (see below). Optimal results in the CometAssay[®] are usually obtained with 200–400 cells per CometSlide[™] sample area. Using 30 µl of a cell suspension at 1 x 10⁵ cells per ml combined with 300 µl of LMAgarose will provide the correct agarose concentration and cell density for optimal results when spreading 30 µl per sample.

Suspension Cells

Cell suspensions are harvested by centrifugation. Suspend cells at 1×10^5 cells/ml in ice cold 1X PBS (Ca^{++} and Mg^{++} free). Media used for cell culture can reduce adhesion of LMAgarose to the CometSlide™.

Adherent Cells

Gently detach cells from flask surface. Transfer cells and medium to a centrifuge tube, perform cell count, and then pellet cells. Wash cells once in ice cold 1X PBS (Ca^{++} and Mg^{++} free). Suspend cells at 1×10^5 cells/ml in ice cold 1X PBS (Ca^{++} and Mg^{++} free). If high level of damage is seen in healthy population, reduce cell exposure to Trypsin or try alternative detachment methods such as scraping using a rubber policeman.

Tissue Preparation

Place a small piece of tissue into 1–2 ml of ice cold 1X PBS (Ca^{++} and Mg^{++} free), 20 mM EDTA. Using small dissecting scissors mince the tissue into very small pieces and let stand for 5 minutes. Recover the cell suspension, avoiding transfer of debris. Count cells, pellet by centrifugation, and suspend at 1×10^5 cells/ml in ice cold 1X PBS (Ca^{++} and Mg^{++} free).

For blood rich organs (e.g., liver, spleen), chop tissue into large pieces ($1\text{--}2 \text{ mm}^3$), let settle for 5 minutes then aspirate and discard medium. Add 1–2 ml of ice cold 20 mM EDTA in 1X PBS (Ca^{++} and Mg^{++} free), mince the tissue into very small pieces and let stand for 5 minutes. Recover the cell suspension, avoiding transfer of debris. Count cells, pellet, and suspend at 1×10^5 cells/ml in ice cold 1X PBS (Ca^{++} and Mg^{++} free).

Controls

A sample of untreated cells should always be processed to control for assay variability, endogenous levels of damage within cells, and for additional damage that may occur during sample preparation. Control cells and treated cells should be handled in an identical manner. If UV damage is being studied, the cells should be kept in low level yellow light during processing. Trevigen offers two sets of suspension cell preparations containing different levels of DNA damage to standardize methods between individual users, different runs and laboratories for alkaline (cat# 4256-010-CC) and neutral (cat# 4257-010-NC) electrophoresis conditions, respectively.

Note: To generate samples positive for comet tails, treat cells with $100 \mu\text{M}$ hydrogen peroxide or $25 \mu\text{M}$ KMnO_4 for 20 minutes at 4°C . Treatment will generate significant oxidative damage in the majority of cells, thereby providing a positive control for each step in the alkaline comet assay.

Method for Cryopreservation of Cells Prior to CometAssay®

Certain cells, e.g., lymphocytes, may be successfully cryopreserved prior to performing CometAssay® (Visvardis *et al.*). A pilot study should be performed to determine if cryopreservation is appropriate for the cells in use.

1. Centrifuge cells at $200 \times g$ for 5 minutes.
2. Suspend cell pellet at 3×10^5 cells/ml in 10% (v/v) dimethylsulfoxide, 40% (v/v) medium, 50% (v/v) fetal calf serum.
3. Transfer $50 \mu\text{l}$ aliquots into freezing vials.
4. Freeze at -70°C with -1°C per minute freezing rate overnight.
5. Transfer to liquid nitrogen for long term storage.
6. Recover cells by submerging in 37°C water bath until the last trace of ice has melted.
7. Add $500 \mu\text{l}$ ice cold 1X PBS (Ca^{++} and Mg^{++} free) to tube.
8. Centrifuge at $200 \times g$ for 10 minutes at 4°C .
9. Suspend in $100 \mu\text{l}$ ice cold 1X PBS (Ca^{++} and Mg^{++} free) at $\sim 1 \times 10^5$ cells/ml and proceed with CometAssay®.

VII. Assay Protocol

The electrophoresis conditions used will determine the sensitivity of the assay. Neutral CometAssay® will detect double-stranded DNA breaks, whereas Alkaline CometAssay® will detect single and double-stranded DNA breaks, and the majority of abasic sites as well as alkali labile DNA adducts (e.g. phosphoglycols, phosphotriesters). The comet assay has been reported to detect DNA damage associated with low doses (0.6 cGy) of gamma irradiation, providing a simple technique for quantitation of low levels of DNA damage. Prior to performing the comet assay, a viability assay should be performed to determine the dose of the test substance that gives at least 90% viability. False positives may occur when high doses of cytotoxic agents are used. For cryopreservation of cells refer to Section VI: *Sample Preparation and Storage*.

The Alkaline CometAssay® requires approximately 2–3 hours to complete, whereas the Neutral CometAssay® requires 4 hours, including the incubations and electrophoresis. Once the cells or tissues have been prepared the procedure is not labor intensive. The Lysis Solution may be cooled and the LMAgarose melted while the cell and tissue samples are being prepared. ***When dealing with large number of samples, a convenient stopping point is to perform cell lysis overnight (Alkaline step 5). In addition, cryopreservation allows experimental samples to be processed concurrently.***

A. Alkaline CometAssay®

1. Prepare Lysis Solution (see Section V: *Reagent Preparation*) and cool at 4°C for at least 20 minutes before use.
2. Melt LMAgarose in a beaker of boiling water for 5 minutes, with the cap loosened. Place bottle in a 37°C water bath for at least 20 minutes to cool. The temperature of the agarose is critical or the cells may undergo heat shock.
3. Combine cells at $1 \times 10^5/\text{ml}$ with molten LMAgarose (at 37°C) at a ratio of 1:10 (v/v) and immediately pipette $30 \mu\text{l}$ onto 20 well CometSlide™. If necessary, use side of pipette tip to spread agarose/cells over sample area to ensure complete coverage of the sample area. If sample is not spreading evenly warm the slide at 37°C before application.

When working with many samples aliquot agarose into 37°C warmed tubes, add cells, mix gently by inversion, and spread 30 µl aliquots onto sample area.

Comet LMAgarose (molten and at 37°C from step 2) 300 µl
 Cells in 1X PBS (Ca⁺⁺ and Mg⁺⁺ free) at 1 x 10⁵/ml 30 µl

4. Place slide flat at 4°C in the dark (e.g., place in refrigerator) for 10 minutes. A 0.5 mm clear ring appears at edge of CometSlide™ area. Increasing gelling time to 30 minutes improves adherence of samples in high humidity environments.
5. Immerse slide in 4°C Lysis Solution for 30-60 minutes. For added sensitivity or convenience incubate overnight at 4°C.
6. Drain excess buffer from slide and immerse in freshly prepared Alkaline Unwinding Solution, pH>13 (see Section V: *Reagent Preparation*). WEAR GLOVES WHEN PREPARING OR HANDLING THIS SOLUTION.
7. Immerse CometSlide™ in Alkaline Unwinding Solution for 20 minutes at room temperature or 1 hour at 4°C, in the dark.
8. For the CometAssay® ES unit, add ~850 ml 4°C Alkaline Electrophoresis Solution, place slides in electrophoresis slide tray (slide label adjacent to black cathode) and cover with Slide Tray Overlay. Set power supply to 21 volts and apply voltage for 30 minutes. (If not using an ES unit, please see Appendix B.)
9. Drain excess electrophoresis solution from slide and gently immerse twice in dH₂O for 5 minutes each, then in 70% ethanol for 5 minutes. *Do not pour liquid over slides.*
10. Dry samples at 37°C for 10-15 minutes. Drying brings all the cells in a single plane to facilitate observation. Samples may be stored at room temperature, with desiccant prior to scoring at this stage.

Note: Trevigen offers CometAssay® Silver Staining Kits designed for comet staining (Cat# 4254-200-K). Silver staining allows visualization of comets on any transmission light microscope and permanently stains the samples for archiving and long term storage. It is recommended that samples be dried before silver staining.

11. Place 50 µl of diluted SYBR® Gold (See Section V: *Reagent Preparation*) onto each circle of dried agarose and stain 30 minutes (room temperature) in the dark. Gently tap slide to remove excess SYBR solution and rinse briefly in water. Allow slide to dry completely at 37°C.
12. View slide by epifluorescence microscopy. (SYBR® Gold's maximum excitation/emission is 496 nm/540 nm. Fluorescein filter is adequate).

B. Neutral CometAssay®

1. Prepare Lysis Solution (see Section V: *Reagent Preparation*) and cool at 4°C for at least 20 minutes before use.
2. Melt LMAgarose in a beaker of boiling water for 5 minutes, with the cap loosened, and then cool in a 37°C water bath for at least 20 minutes.
3. Combine cells at 1 x 10⁵/ml with molten LMAgarose (at 37°C) at a ratio of 1:10 (v/v) and immediately pipette 30 µl onto CometSlide™. Use side of pipette tip to spread agarose/cells over sample area.

Comet LMAgarose (molten and at 37°C from step 2) 300 µl
 Cells in 1X PBS (Ca⁺⁺ and Mg⁺⁺ free) at 1 x 10⁵/ml 30 µl

Note: If sample is not spreading evenly on the slide, warm the slide at 37°C before application.

4. Place slide flat at 4°C in the dark (e.g. place in refrigerator) for 10 minutes. A 0.5 mm clear ring appears at edge of CometSlide™ area. Increasing gelling time to 30 minutes improves adherence of samples in high humidity environments.
5. Immerse slide in 4°C (Step 1) Lysis Solution for 1 hour or overnight for added sensitivity.
6. Remove slide from Lysis Buffer, drain excess buffer from slide and gently immerse in 50 ml 4°C 1X Neutral Electrophoresis Buffer for 30 minutes (see Section V: *Reagent Preparation*).
7. For the CometAssay® ES unit, add ~850 ml 4°C 1X Neutral Electrophoresis Buffer, place slide in electrophoresis slide tray (slide label adjacent to black cathode) and cover with Slide Tray Overlay. Set power supply to 21 volts and apply voltage for 45 minutes at 4°C.

For other electrophoresis units, align slides equidistant from electrodes, add 1X Neutral Electrophoresis Buffer not to exceed 0.5 cm above slides, and apply voltage at 1 volt per cm (measured electrode to electrode).

8. Drain excess Neutral Electrophoresis Buffer and gently immerse slide in DNA Precipitation Solution for 30 minutes at room temperature.
9. Immerse slide in 70% ethanol for 30 minutes at room temperature.
10. Dry samples at 37°C for 10-15 minutes. Drying brings all the cells in a single plane to facilitate observation. Samples may be stored at room temperature, with desiccant prior to scoring at this stage.

Note: Trevigen offers the CometAssay® Silver Staining Kit designed for comet staining (cat# 4254-200-K). Silver staining allows visualization of comets on any transmission light microscope and permanently stains the

samples for archiving and long term storage. It is recommended that samples be dried before silver staining.

11. Place 50 µl of diluted SYBR® Gold onto each circle of dried agarose and stain 30 minutes (room temperature) in the dark. Gently tap slide to remove excess SYBR solution. Allow slide to dry completely at 37°C.
12. View slide by epifluorescence microscopy. (SYBR® Gold's maximum excitation/emission is 496 nm/540 nm. Fluorescein filter is adequate.)

VIII. Data Analysis

When excited (425–500 nm) the DNA-bound SYBR® Gold emits green light. In healthy cells the fluorescence is confined to the nucleoid (comprised of high molecular weight DNA): undamaged DNA is supercoiled and thus, does not migrate very far out of the nucleoid under the influence of an electric current. Whereas in cells that have accrued DNA damage, migrating fragments (comet tail) from the nucleoid (comet head) are observed. The negatively charged DNA migrates toward the anode and the extrusion length reflects increasing relaxation of supercoiling, which is indicative of damage. Common descriptors of DNA damage for alkaline comet assays are Percent DNA in the Tail, and Tail Moment. Percent DNA in the Tail is a normalized measure of the percent of total cell DNA found in the tail. Tail moment is a damage measure combining the amount of DNA in the tail with distance of migration. In neutral comet assays, Tail Moment is primarily used, since tail length continues to increase in contrast to alkaline comet tails which have finite lengths.

Qualitative Analysis (Alkaline CometAssay®)

The comet tail can be scored according to DNA content (intensity). The control (untreated cells) should be used to determine the characteristics of data for a healthy cell. Scoring can then be made according to nominal, medium or high intensity tail DNA content. At least 50 cells should be scored per sample.

Quantitative Analysis (Alkaline and Neutral CometAssay®)

There are several image analysis systems that are suitable for quantitation of CometAssay® data. The more sophisticated systems include the microscope, camera and computer analysis package. These systems can be set up to measure the length of DNA migration, image length, nuclear size, and calculate DNA damage parameters. At least 50 randomly selected cells should be analyzed per sample.

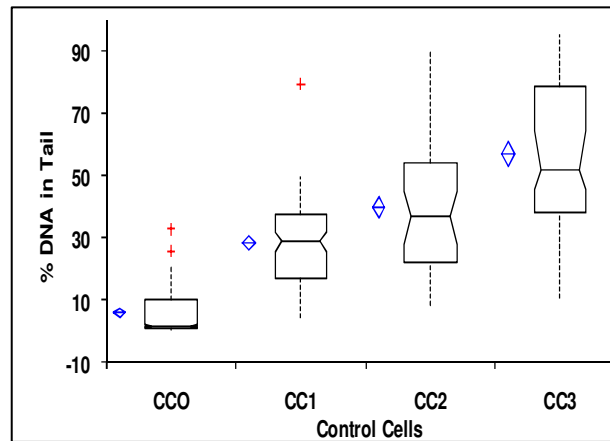
A list of commercially available software package is available from Trevigen.

Featured Data:

Alkaline CometAssay®

In Figure 1a, data collected for each alkaline CometAssay® Control Cell population (cat# 4256-010-CC) is shown as side-by-side vertical box plots for comparison. The diamond shows the mean and confidence interval around the mean. The notched box shows the median, lower and upper quartiles, and the 75% confidence interval around the median. An example is provided below.

Figure 1a: Box-Whisker plot of Control Cells: Percent DNA in Comet Tail



% DNA by Etoposide	n	Mean	SD	SE	75% CI of Mean	Median	IQR	75% CI of Median
CC0	50	5.757	7.7270	1.0928	4.485 to 7.029	1.640	8.925	1.290 to 2.230
CC1	50	28.374	14.0080	1.9810	26.068 to 30.680	28.990	20.313	25.180 to 31.840
CC2	50	39.736	21.8164	3.0853	36.144 to 43.328	37.050	32.183	27.790 to 44.630
CC3	50	56.800	23.5893	3.3360	52.916 to 60.683	51.905	40.240	45.460 to 64.390

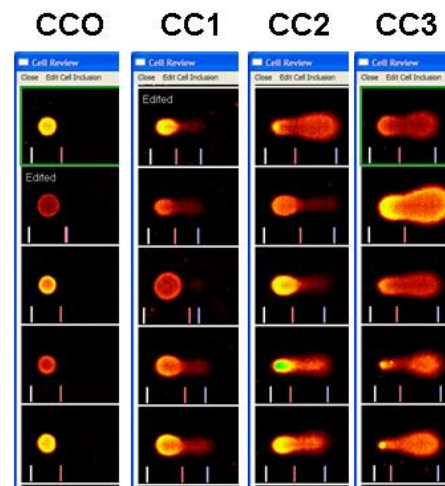
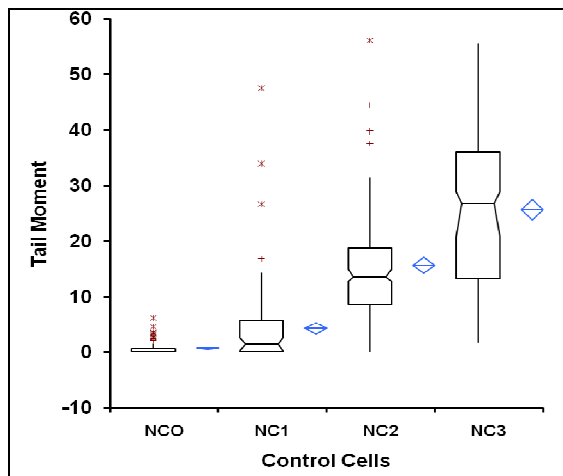


Figure 1b: Examples of comet tail shapes for each population.

Neutral CometAssay[®]

Data collected for each Neutral CometAssay[®] Control Cell population (cat# 4257-010-NC) is provided below.

Figure 2a: Box-Whisker plot of Neutral Control Cells: Tail Moment



TM by Bleomycin	n	Mean	SD	SE	75% CI	Median	IQR	75% CI
NCO	75	0.677	1.2410	0.1433	0.511 to 0.843	0.000	0.637	0.000 to 0.140
NC1	75	4.316	7.7817	0.8986	3.274 to 5.358	1.360	5.748	0.240 to 2.510
NC2	75	15.711	10.7829	1.2451	14.268 to 17.155	13.600	10.117	12.830 to 14.950
NC3	75	25.730	13.7918	1.5925	23.884 to 27.577	26.780	22.750	20.810 to 28.930

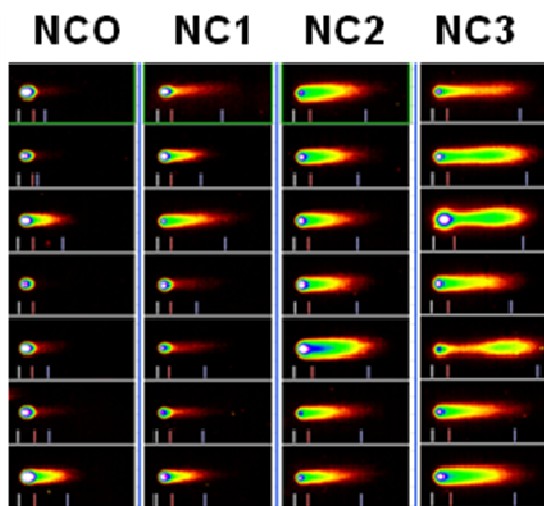


Figure 2b: Examples of comet tail shapes for each population.

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X. Related Products Available From Trevigen

Contact Trevigen for details of our unique product line for studying DNA damage and repair. All of Trevigen's kits include highly qualified enzymes, substrates, buffers, full instructions for use, and a synopsis specific for your kit.

CometAssay[®] Kits:

Catalog #	Description	Size
4250-050-ESK	CometAssay [®] Starter Kit	each
4250-050-ES	CometAssay [®] ES	each
4250-050-K	CometAssay [®] Kit	50 samples
4251-050-K	CometAssay [®] Silver Kit	50 samples
4254-200-K	CometAssay [®] Silver Staining Kit	200 samples
4253-096-K	CometAssay [®] Kit 96 Wells	96 samples

PARP Assay Kits:

Catalog #	Description	Size
4520-096-K	HT PARP in vivo Pharmacodynamic Assay II	96 tests
4676-096-K	HT Universal Chemiluminescent PARP Assay	96 tests
4677-096-K	HT Universal Colorimetric PARP Assay	96 tests
4684-096-K	HT Colorimetric PARP/Apoptosis Assay	96 tests
4685-096-K	HT Chemiluminescent PARP /Apoptosis Assay	96 tests
4690-096-K	HT Homogeneous PARP Inhibition Assay	96 tests

FLARE™ Assay Kits:

Catalog #	Description	Damage Recognized	Size
4040-100-FK 4040-100-FM	Fpg Kit	8-oxoguanine, DNA containing formamidopyrimidine moieties	75 samples 100 samples
4055-100-FK 4055-100-FM	T4-PDG Kit	Cis-syn isomers of cyclobutane pyrimidine dimers	75 samples 100 samples
4130-100-FK 4130-100-FM	hOGG1 Kit	8-oxoguanine, DNA containing formamidopyrimidine moieties	75 samples 100 samples
4100-100-FK 4100-100-FM	UVDE Kit	Cyclobutane pyrimidine dimers, (6-4) photoproducts	75 samples 100 samples
4045-01K-FK 4045-01K-FM	Endonuclease III Kit	Thymine Glycol, 5,6-dihydrothymine, urea, 5-hydroxy-6-hydroxy-thymine, 5,6-dihydro-uracil, alloxan, 5-hydroxy-6-hydroxy-uracil, uracil glycol, 5-hydroxy-5-methylthio-dantoin, 5-hydroxycytosine, 5-hydroxy-uracil, methyl-tartonylurea, thymine ring saturated or fragmentation product	75 samples 100 samples

Accessories:

Catalog #	Description	Size
3950-300-02	FLARE™ Slides	100 slides
3950-075-SP	FLARE™ Sample Prep	>100 samples
4250-050-03	CometSlide™ (2 well)	25 slides
4252-200-01	CometAssay® HT Slide (20 well)	10 slides
4253-960-03	96 Well CometSlide™	10 slides
4256-010-CC	CometAssay® Control Cells (alkaline assay)	1 set
4257-010-NC	Neutral CometAssay® Control Cells	1 set
4380-096-K	HT 8-oxo-dG ELISA Kit II	96 wells
4866-20	Fluorescence Mounting Medium	20 ml
4870-500	10X PBS, Ca ⁺⁺ and Mg ⁺⁺ free	500 ml

XI. Appendices

Appendix A

Neutral CometAssay®

The CometAssay® may be performed using neutral conditions that employ 1X TBE. Without treatment with Alkaline Buffer, this Neutral CometAssay® will also detect mainly double-stranded breaks.

1. Prepare Lysis Solution (see Section V: *Reagent Preparation*) and cool to 4°C for at least 20 minutes before use.
2. Melt LMAgarose in a beaker of boiling water for 5 minutes, with the cap loosened, and then cool in a 37°C water bath for at least 20 minutes.

3. Combine cells at 1 x 10⁵/ml with molten LMAgarose (at 37°C) at a ratio of 1:10 (v/v) and immediately pipette 30 µl onto CometSlide™. Use side of pipette tip to spread agarose/cells over sample area.

Comet LMAgarose (molten and at 37°C from step 2)	300 µl
Cells in 1X PBS (Ca ⁺⁺ and Mg ⁺⁺ free) at 1 x 10 ⁵ /ml	30 µl

Note: If sample is not spreading evenly on the slide, warm the slide at 37°C before application.

4. Place slide flat at 4°C in the dark (*e.g.* place in refrigerator) for 10 minutes. A 0.5 mm clear ring appears at edge of CometSlide™ area. Increasing gelling time to 30 minutes improves adherence of samples in high humidity environments.
5. Immerse slide in 4°C (Step 1) Lysis Solution for 1 hour or overnight for added sensitivity.
6. Remove slides from Lysis Buffer, drain excess buffer from slide and wash slide by immersing in 50 ml of 4°C 1X TBE buffer for 15 minutes.

To prepare 10X TBE:

Tris Base	108 g
Boric Acid	55 g
EDTA (disodium salt)	9.3 g

Dissolve in 900 ml dH₂O. Adjust volume to 1 liter, filter sterilize, and store at room temperature. Dilute the 10X TBE to 1X in dH₂O to prepare 1 liter working strength buffer and cool to 4°C.

7. For the CometAssay® ES unit, add ~850 ml 4°C 1X TBE Buffer, place slide in electrophoresis slide tray and cover with Slide Tray Overlay. Set power supply to 21 volts and apply voltage for 40 minutes.

Note: For other electrophoresis units, align slides equidistant from electrodes, add 1X TBE Buffer not to exceed 0.5 cm above slides, and apply voltage at 1 volt per cm (measured electrode to electrode).

8. Drain excess TBE, immerse slide in dH₂O for 5 minutes.
9. Immerse slide in 70% ethanol for 5 minutes.

10. Dry samples at 37°C for 10-15 minutes. Drying brings all the cells in a single plane to facilitate observation. Samples may be stored at room temperature, with desiccant prior to scoring at this stage.

11. Place 50 µl of diluted SYBR® Gold (see Section V: *Reagent Preparation*) onto each circle of dried agarose and stain 30 minutes (room temperature) in the dark. Gently tap slide to remove excess SYBR solution and rinse briefly in water. Allow slide to dry completely at 37°C.

12. View slide by epifluorescence microscopy using. (SYBR[®] Gold's maximum excitation/emission is 496 nm/540 nm. Fluorescein filter is adequate.)

Appendix B
Instructions for alkaline comet assay with other electrophoresis units.

Since the Alkaline Electrophoresis Solution is a non-buffered system, **temperature control is highly recommended.** In-house testing has shown great temperature fluctuations when conducting the alkaline electrophoresis at ambient temperature. To improve temperature control, the use of a large electrophoresis apparatus (20–30 cm between electrodes) is recommended. Performing the electrophoresis at cooler temperatures (*e.g.* 4°C) will diminish background damage, increase sample adherence at high pH and significantly improves reproducibility. Choose the method that is most convenient for your laboratory and always use the same conditions, CometAssay[®] Control Cells (cat# 4256-010-CC), power supplies and electrophoresis chambers for comparative analysis.

Alternative Reagents:

1. Alkaline Unwinding Solution, pH>13 (300 mM NaOH, 1 mM EDTA)

Wear gloves when preparing and handling the Alkaline Unwinding Solution. Per 50 ml of Alkaline Solution combine:

NaOH Pellets	0.6 g
200 mM EDTA (cat # 4250-050-04)	250 µl
dH ₂ O	49.75 ml

Stir until fully dissolved. The solution will warm during preparation. Allow to cool to room temperature before use.

2. Alkaline Electrophoresis Solution pH >13 (300 mM NaOH, 1 mM EDTA) for other electrophoresis systems:

Prepare a stock solution of 500 mM EDTA, pH 8.

For 1 liter of electrophoresis solution:

NaOH pellets	12 g
500 mM EDTA, pH 8	2 ml
dH ₂ O (after NaOH is dissolved) add to:	1 liter

Adjust the volume prepared based on the dimensions of your electrophoresis apparatus. Use of freshly made solution is recommended. Cool to 4°C.

Align slides equidistant from electrodes and carefully add the Alkaline Solution until level just covers samples. Set the voltage to about 1 Volt/cm. Add or remove buffer until the current is approximately 300 mA and perform electrophoresis for 20–40 minutes.

Continue at step 9 on page 7.

Appendix C
DNA Stains

1. Important parameters to consider in choosing a DNA stain for the alkaline comet assay are similar fluorescence and decay rates for single- and double-strand DNA.

Table 1: DNA Stains Parameters (Cosa *et al.*)

Dye	Abs/Em (nm)	ss:dsDNA fluorescence	ss:dsDNA decay	Signal:Bkgrd
EtBr	520/608	1.0	0.89	~10
DAPI	356/455	0.55	0.85	~20
Propidium Iodide	536/624	0.93	0.93	~20
SYBR Gold	496/540	0.84	0.74	>1000
SYBR Green	496/522	0.57	0.47	>1000
YoYo-1	490/507	0.66	0.73	~400

2. To use SYBR Green instead of SYBR Gold, simply prepare 1:10,000X SYBR[®] Green I Staining Solution. The diluted stock is stable for several weeks when stored at 4°C in the dark.

SYBR [®] Green I (10,000X concentrate in DMSO)	1 µl
TE Buffer, pH 7.5	10 ml
(TE: 10 mM Tris-HCl pH 7.5, 1 mM EDTA)	

XII. Troubleshooting Guide

General Problems

PROBLEM	CAUSE	ACTION
Unexpected and/or variety of tail shape.	LM Agarose too hot	Cool LM Agarose to 37°C before adding cells.
Cells in LM Agarose did not remain attached to the CometSlide™.	Electrophoresis solution too hot.	Control temperature performing electrophoresis at 4°C.
	Cells were not washed to remove medium before combining with LM Agarose.	The pH of medium and carry over serum proteins, etc., can reduce the adherence of the agarose. Suspend cells in 1X PBS.
	Agarose percentage was too low.	Do not increase ratio of cells to molten agarose by more than 1 to 10.
	LM Agarose was not fully set before samples were processed.	Ensure 0.5 mm dried ring due to agarose disc retraction is seen at the edge of the CometSlide area.
	LM Agarose unevenly set on the slide.	Spread the agarose with the side of a pipette tip to ensure uniformity of agarose disc and better adherence.
	Rinsing steps too harsh.	Gently place slides into solutions. Do not pour solutions over slides.

Specific to Alkaline Comet Assay

PROBLEM	CAUSE	ACTION
Majority of cells in untreated control sample have large comet tails.	Unwanted damage to cells occurred in culture or in sample preparations Electrophoresis solution too hot Intracellular activity	Check morphology of cells to ensure healthy appearance. Handle cells or tissues gently to avoid physical damage. Control temperature by performing electrophoresis at 4°C. Keep cells on ice and prepare cell samples immediately before combining with molten LMAgarose.
Majority of cells in untreated control sample have small to medium comet tails.	Endogenous oxidative damage or endonuclease activity after sample preparation is damaging DNA.	Ensure Lysis solution was chilled before use. Add DMSO to any cell sample that may contain heme groups. Ensure PBS used is calcium and magnesium free. Work under dimmed light conditions or under yellow light.
In positive control (e.g. 100 µM hydrogen peroxide for 30 minutes on ice) no evidence of comet tail.	No damage to DNA. Sample was not processed correctly.	Use fresh hydrogen peroxide to induce damage. Ensure each step in protocol was performed correctly. Failure to lyse, denature in alkali, or to properly perform electrophoresis may generate poor results.
Comet tails present but not significant in positive control.	Insufficient denaturation in Alkaline Solution. Insufficient electrophoresis time.	Increase time in Alkaline Solution up to 1 hour. Increase time of electrophoresis up to up to 1 hour for alkaline electrophoresis. Increase time of electrophoresis when running at cold temperatures.

Specific to Neutral Comet Assay

PROBLEM	CAUSE	ACTION
In positive control no evidence of comet tail.	Damaging agent doesn't cause double-strand breaks.	Confirm damage by Alkaline Comet. Run Neutral Control Cells to confirm electrophoresis conditions. Increase treatment with damaging agent.
In positive control comet tails are extremely long and do not fit analysis window.	Cells are necrotic or apoptotic. Electrophoresis time too long.	Verify 90% viability. Decrease treatment with damaging agent. Decrease electrophoresis time to 15-30 minutes.

The product accompanying this document is intended for research use only and is not intended for diagnostic purposes or for use in humans.

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