

# **TREVIGEN® Instructions**

*For Research Use Only. Not For Use In Diagnostic Procedures*

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## **CometAssay®**

### **Reagent Kit for Single Cell Gel Electrophoresis Assay**

**Catalog # 4250-050-K**

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## I. Background

Trevigen's CometAssay<sup>®</sup>, 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<sup>®</sup> is typically used to detect double-stranded breaks, whereas the Alkaline CometAssay<sup>®</sup> is more sensitive, and is used to detect smaller amounts of damage including single and double-stranded breaks.

Trevigen's CometAssay<sup>®</sup> uses our exclusive 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 Trevigen's CometSlide™ shortens assay time and allows 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<sup>®</sup>, 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<sup>®</sup> Control Cells (cat# 4256-010-CC) when performing alkaline electrophoresis, and Neutral CometAssay<sup>®</sup> Control Cells (cat# 4257-010-NC) when performing the neutral comet assay, to monitor assay conditions and verify reproducibility between separate runs. Trevigen also provides SYBR<sup>®</sup> Green I<sup>1</sup> for DNA visualization by epifluorescence microscopy, providing improved sensitivity compared to ethidium bromide. 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<sup>®</sup> 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<sup>®</sup> 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.

<sup>1</sup> SYBR<sup>®</sup> Green I is a registered product of Molecular Probes, Eugene OR, and is sold under license from Molecular Probes, Inc. Please see p.18 for complete licensing terms. Use of this reagent outside of the scope of these terms is not endorsed by Trevigen, Inc.

## 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<sup>®</sup> 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<sup>®</sup> Green I contains DMSO. Please refer to MSDS sheets.

## III. Materials Supplied

<u>Component</u>	<u>Catalog #</u>	<u>Amount</u>	<u>Storage</u>
Lysis Solution	4250-050-01	2 x 500 ml	Room temp.
Comet LMAgarose (LMA)	4250-050-02	15 ml	4°C
Trevigen CometSlide™	4250-050-03	25 each	Room temp.
200 mM EDTA, pH 10	4250-050-04	12.5 ml	Room temp.
SYBR <sup>®</sup> Green I nucleic acid gel stain	4250-050-05	5 µl	-20°C

## 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 pipets
3. Boiling water bath and 37°C water bath
4. Horizontal electrophoresis apparatus (CometAssay<sup>®</sup> ES 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

### Reagents:

1. Deionized water
2. 10X PBS, Ca<sup>++</sup> and Mg<sup>++</sup> free\* (cat# 4870-500-6)
3. 95% Ethanol (reagent grade)
4. TE Buffer (10 mM Tris (pH 7.5), 1 mM EDTA)

### For alkaline assays:

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

### For neutral assays:

7. 10X Neutral Electrophoresis Buffer
8. Ammonium Acetate
9. Sodium Acetate
10. Glacial Acetic Acid

### Optional reagents:

11. Silver staining kit\* (cat# 4254-050-K)
12. Dimethylsulfoxide
13. Tris Borate EDTA buffer

\*Available from Trevigen.

## V. Reagent Preparation

Reagents marked with an asterisk (\*) should be prepared immediately before use. Wear gloves, lab coat and eye protection when handling any chemical reagents.

### 1. 1X PBS, Ca<sup>++</sup> and Mg<sup>++</sup> free

Dilute 10X PBS with deionized water to prepare 1X PBS. Store at room temperature. (10X PBS is available from Trevigen, cat# 4870-500-6.)

### 2. Lysis Solution

For up to 10 slides (2 samples per slide) prepare:

Lysis Solution (cat # 4250-050-01)	40 ml
DMSO (optional)	4 ml

Chill at 4°C, or on ice, for at least 20 minutes before use. 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® Green I Staining Solution

Prepare SYBR® Green I Staining Solution from the SYBR® Green I concentrate provided (10,000X concentrate in DMSO).

SYBR® Green I (cat # 4250-050-05)	1 µl
TE Buffer, pH 7.5	10 ml

(TE: 10 mM Tris-HCl pH 7.5, 1 mM EDTA)

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

### 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. Re-staining of slides is not recommended. Anti-fade solution is stored at -20°C for one month. Darkening of solution may occur.

## 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 <sub>2</sub> 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 <sub>2</sub> O (after NaOH is dissolved) q.s. to:	1 liter

Use of freshly made solution is recommended. Prechill at 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 dH<sub>2</sub>O. Adjust to pH = 9.0 with glacial acetic acid. Adjust volume to 500 ml and filter sterilize. Store at room temperature. Dilute the 10X stock to 1X in dH<sub>2</sub>O to prepare 1 liter working strength buffer and prechill at 4°C.

### 9. DNA Precipitation Solution

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

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

For 50 ml of DNA precipitation solution combine:

7.5 M NH <sub>4</sub> 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 chilled to 4°C or on ice to inhibit endogenous damage occurring during sample preparation and to inhibit repair in the unfixed 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 500–1000 cells per CometSlide™ sample area. Using 50 µl of a cell suspension at 1 x 10<sup>5</sup> cells per

ml combined with 500  $\mu$ l of LMAgarose will provide the correct agarose concentration and cell density for optimal results when spreading 50  $\mu$ l per well.

### **Suspension Cells**

Cell suspensions are harvested by centrifugation. Resuspend cells at  $1 \times 10^5$  cells/ml in ice cold 1X PBS ( $\text{Ca}^{++}$  and  $\text{Mg}^{++}$  free). The media used for cell culture can reduce the adhesion of the agarose on the CometSlide™.

### **Adherent Cells**

Gently scrape cells using a rubber policeman. Transfer cells and medium to centrifuge tube, perform cell count, and then pellet cells. Wash once in ice cold 1X PBS ( $\text{Ca}^{++}$  and  $\text{Mg}^{++}$  free). Resuspend cells at  $1 \times 10^5$  cells/ml in ice cold 1X PBS ( $\text{Ca}^{++}$  and  $\text{Mg}^{++}$  free).

### **Tissue Preparation**

Place a small piece of tissue into 1–2 ml of ice cold 1X PBS ( $\text{Ca}^{++}$  and  $\text{Mg}^{++}$  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 resuspend at  $1 \times 10^5$  cells/ml in ice cold 1X PBS ( $\text{Ca}^{++}$  and  $\text{Mg}^{++}$  free). For blood rich organs (e.g., liver, spleen), chop tissue into large pieces (1–2  $\text{mm}^3$ ), let settle for 5 minutes then aspirate and discard medium. Add 1–2 ml of ice cold 20 mM EDTA in 1X PBS ( $\text{Ca}^{++}$  and  $\text{Mg}^{++}$  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 resuspend at  $1 \times 10^5$  cells/ml in ice cold 1X PBS ( $\text{Ca}^{++}$  and  $\text{Mg}^{++}$  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  $\mu$ M hydrogen peroxide or 25  $\mu$ M  $\text{KMnO}_4$  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 x g for 5 minutes.
2. Resuspend cell pellet at  $1 \times 10^7$  cells/ml in 10% (v/v) dimethylsulfoxide, 40% (v/v) medium, 50% (v/v) fetal calf serum.
3. Transfer aliquots of  $2 \times 10^6$  cells into freezing vials.

4. Freeze at –70°C with –1°C per minute freezing rate.
5. Recover cells by submerging in 37°C water bath until the last trace of ice has melted.
6. Transfer to 15 ml of prechilled 40% (v/v) medium, 10% (w/v) dextrose, 50% (v/v) fetal calf serum.
7. Centrifuge at 200 x g for 10 minutes at 4°C.
8. Resuspend in ice cold 1X PBS ( $\text{Ca}^{++}$  and  $\text{Mg}^{++}$  free) 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 75% viability. False positives may occur when high doses of cytotoxic agents are used. For cryopreservation of cells, fixing the CometSlide™ samples, and storage, 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 chilled and the LMAgarose melted while the cell and tissue samples are being prepared.

### **A. Alkaline CometAssay®**

1. Prepare Lysis Solution (see Section V: *Reagent Preparation*) and chill at 4°C or on ice 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. Heat blocks are not recommended for regulating the temperature of the agarose.
3. Combine cells at  $1 \times 10^5$ /ml with molten LMAgarose (at 37°C) at a ratio of 1:10 (v/v) and immediately pipette 50  $\mu$ l onto CometSlide™. If necessary, use side of pipette tip to spread agarose/cells over sample area to ensure complete coverage of the sample area. When working with many samples it may be convenient to place aliquots of the molten agarose into prewarmed microcentrifuge tubes and place the tubes at 37°C. Add cells to one tube, mix by gently pipetting once or twice, then transfer 50  $\mu$ l aliquots onto each sample area as required. Then proceed with the next sample of cells.

Comet LMAgarose (molten and at 37°C from step 2)	500 µl
Cells in 1X PBS (Ca <sup>++</sup> and Mg <sup>++</sup> free) at 1 x 10 <sup>5</sup> /ml	50 µl

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

- Place slides 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.
- Immerse slides in prechilled Lysis Solution and leave on ice, or at 4°C, for 30 minutes to 60 minutes.
- Drain excess buffer from slides and immerse in freshly prepared Alkaline Unwinding Solution, pH>13 (see Section V: *Reagent Preparation*). WEAR GLOVES WHEN PREPARING OR HANDLING THIS SOLUTION.
- Leave CometSlide™ in Alkaline Unwinding Solution for 20 to 60 minutes at room temperature, in the dark.
- For the CometAssay® ES tank, add 950 ml prechilled Alkaline Electrophoresis Solution, place slides in electrophoresis slide tray and cover with Slide Tray Overlay. Set power supply to 21 volts and apply voltage for 30 minutes. (If not using an ES unit, see Appendix B.)
- Gently drain excess electrophoresis solution, immerse twice in dH<sub>2</sub>O for 5 minutes each, then in 70% ethanol for 5 minutes.
- Dry samples at ≤ 45°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.

- Place 100 µl of diluted SYBR® Green I (See Section V: *Reagent Preparation*) onto each circle of dried agarose and place in refrigerator for 5 minutes. Gently tap slide to remove excess SYBR solution. Allow slides to dry completely at room temperature in the dark.
- View slides by epifluorescence microscopy. (SYBR® Green I's maximum excitation and emission are respectively 494 nm/521 nm. Fluorescein filter is adequate).

## B. Neutral CometAssay®

- Prepare Lysis Solution (see Section V: *Reagent Preparation*) and chill at 4°C or on ice for at least 20 minutes before use.
- 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.
- Combine cells at 1 x 10<sup>5</sup>/ml with molten LMAgarose (at 37°C) at a ratio of 1:10 (v/v) and immediately pipette 50 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)	500 µl
Cells in 1X PBS (Ca <sup>++</sup> and Mg <sup>++</sup> free) at 1 x 10 <sup>5</sup> /ml	50 µl

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

- Place slides 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.
- Immerse slides in prechilled (Step 1) Lysis Solution and leave on ice or at 4°C for 1 hour.
- Remove slides from Lysis Buffer, drain excess buffer from slide and wash slide by immersing in 50 ml of prechilled 1X Neutral Electrophoresis Buffer for 30 minutes at 4°C (see Section V: *Reagent Preparation*).
- For the CometAssay® ES tank, add 950 ml prechilled 1X Neutral Electrophoresis Buffer, place slides in electrophoresis slide tray and cover with Slide Tray Overlay. Set power supply to 21 volts and apply voltage for 1 hour 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).
- Drain excess Neutral Electrophoresis Buffer and immerse slides in DNA Precipitation Solution for 30 minutes at room temperature.
- Immerse slides in 70% ethanol for 30 minutes at room temperature.
- Dry samples at ≤ 45°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 100 µl of diluted SYBR® Green I onto each sample for 30 minutes. Gently tap slide to remove excess SYBR solution. Allow slide to dry completely at room temperature in the dark.
12. View slide by epifluorescence microscopy using (Fluorescein filter is adequate). (SYBR® Green I's maximum excitation and emission are respectively 494 nm/521 nm.)

### VIII. Data Analysis

When excited (425–500 nm) the DNA-bound SYBR® Green I 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

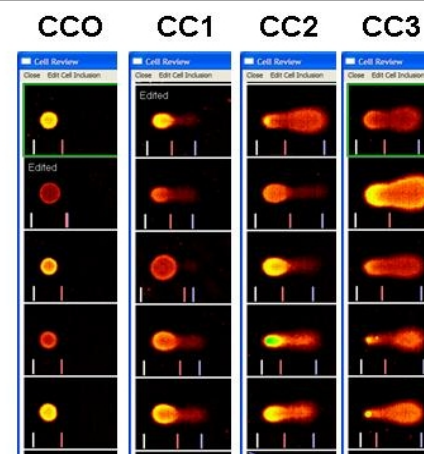
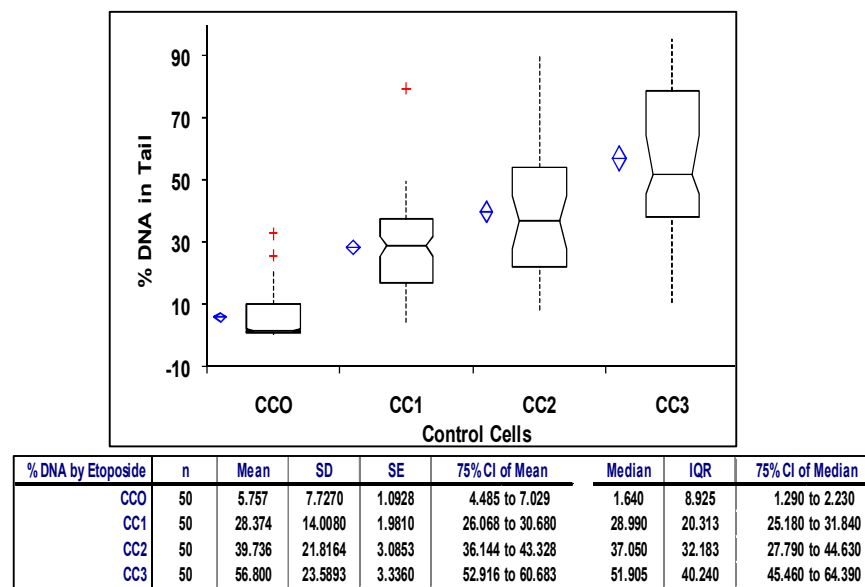
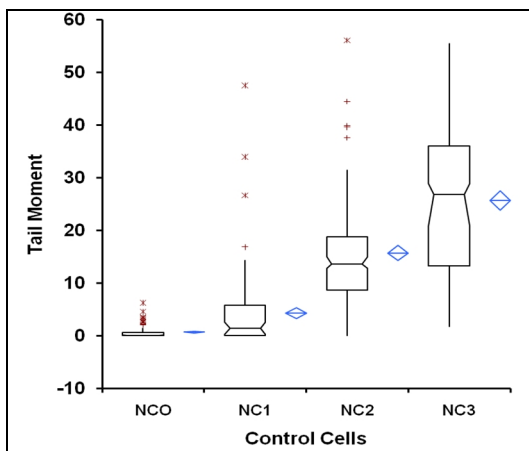


Figure 1b: Examples of comet tails for each population.

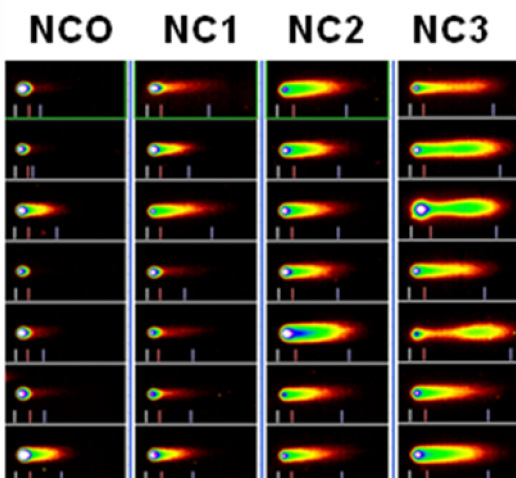
## Neutral CometAssay®

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: Example comet tails for each population.**

## IX. References

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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
4251-050-K	CometAssay® Silver Kit	50 samples
4254-200-K	CometAssay® Silver Staining Kit	200 samples
4252-040-K	CometAssay® Higher Throughput Kit	40 samples
4253-096-K	CometAssay® Kit 96 Wells	96 samples

### PARP Assay Kits:

Catalog #	Description	Size
4684-096-K	HT Colorimetric PARP/Apoptosis Assay	96 tests
4685-096-K	HT Chemiluminescent PARP /Apoptosis Assay	96 tests
4520-096-K	HT PARP in vivo Pharmacodynamic Assay II	96 tests

## FLARE™ Assay Kits:

Catalog #	Description	Damage Recognized	Size
4040-100-FK	Fpg Kit	8-oxoguanine, DNA containing formamidopyrimidine moieties	75 samples
4040-100-FM			100 samples
4055-100-FK	T4-PDG Kit	Cis-syn isomers of cyclobutane pyrimidine dimers	75 samples
4055-100-FM			100 samples
4065-100-FK	cv-PDG Kit	Cis-syn and trans-syn isomers of cyclobutane pyrimidine dimers	75 samples
4065-100-FM			100 samples
4130-100-FK	hOGG1 Kit	8-oxoguanine, DNA containing formamidopyrimidine moieties	75 samples
4130-100-FM			100 samples
4100-100-FK	UVDE Kit	Cyclobutane pyrimidine dimers, (6-4) photoproducts	75 samples
4100-100-FM			100 samples
4045-01K-FK	Endonuclease III Kit	Thymine Glycol, 5,6-dihydrothymine, urea, 5-hydroxy-6-hydrothymine, 5,6-dihydro-uracil, alloxan, 5-hydroxy-6-hydrouracil, uracil glycol, 5-hydroxy-5-methylhydantoin, 5-hydroxycytosine, 5-hydroxy-uracil, methyl-tartronylurea, thymine ring saturated or fragmentation product	75 samples
4045-01K-FM			100 samples

## DNA Damage Antibodies:

Catalog #	Description	Size
4411-PC-100	γ-H2AX	100 µl
4410-PC-100	Fen-1	100 µl
4350-MC-100	UVssDNA	100 µg
4354-MC-50	anti-8-oxo-dG monoclonal	50 µl

## Accessories:

Catalog #	Description	Size
4256-010-CC	CometAssay® Control Cells (alkaline assay)	1 set
4257-010-NC	Neutral CometAssay® Control Cells	1 set
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
3950-300-02	FLARE™ Slides	100 slides
4040-100-FM	Fpg FLARE™ Module	>100 samples
4130-100-FM	hOGG1 FLARE™ Module	>100 samples
4045-100-FM	Endonuclease III FLARE™ Module	>100 samples
4055-100-FM	T4-PDG FLARE™ Module	>100 samples
4065-100-FM	cv-PDG FLARE™ Module	>100 samples
3950-075-SP	FLARE™ Sample Prep	>100 samples
4100-050-FM	UVDE FLARE™ Module	>100 samples
4370-096-K	HT 8-oxo-dG ELISA Kit	96 wells

## 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 chill at 4°C or on ice 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 10<sup>5</sup>/ml with molten LMAgarose (at 37°C) at a ratio of 1:10 (v/v) and immediately pipette 50 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)	500 µl
Cells in 1X PBS (Ca <sup>++</sup> and Mg <sup>++</sup> free) at 1 x 10 <sup>5</sup> /ml	50 µl

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

4. Place slides 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 slides in prechilled (Step 1) Lysis Solution and leave on ice or at 4°C for 30 minutes.
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 dH<sub>2</sub>O. Adjust volume to 1 liter and filter sterilize. Store at room temperature. Dilute the 10X TBE to 1X in dH<sub>2</sub>O to prepare 1 liter working strength buffer and prechill at 4°C.

7. For the CometAssay® ES tank, add 4°C 950 ml 1X TBE Buffer, place slides 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 slides in dH<sub>2</sub>O for 5 minutes.
9. Immerse slides in 70% ethanol for 5 minutes.
10. Dry samples at ≤ 45 °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 100 µl of diluted SYBR<sup>®</sup> Green I onto each sample and place in refrigerator for 5 minutes. Gently tap slide to remove excess SYBR solution. Allow slide to dry completely at room temperature in the dark.
12. View slide by epifluorescence microscopy using (Fluorescein filter is adequate). (SYBR<sup>®</sup> Green I's maximum excitation and emission are respectively 494 nm/521 nm.)

#### **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 pHs and significantly improves reproducibility. Choose the method that is most convenient for your laboratory and always use the same conditions, CometAssay<sup>®</sup> 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 <sub>2</sub> 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 <sub>2</sub> O (after NaOH is dissolved) q.s. to:	1 liter

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

Align slides equidistant from electrodes and carefully add 300 mM NaOH (1 mM EDTA) 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** **Detection of (6-4)-dipyrimidine UV Adducts Using Anti-UVssDNA Antibody**

The anti-UVssDNA antibody (cat # 4350-MC-100) can be used to detect (6-4)-dipyrimidine photoproducts, directly in the comets. The Alkaline CometAssay<sup>®</sup> is performed on the samples as indicated in Section VII: *Assay Protocol*. The staining step is omitted; samples are fixed with ethanol, dried and treated as follows:

1. Cover dried sample area with 10 µg/ml of anti-UVss DNA antibody diluted in 1X PBST, 1% BSA, (PBST: 1X PBS, 0.05% Tween<sup>®</sup> 20) and incubate overnight at 4°C.
2. Wash sample 3 times with 1X PBST for 5 minutes each.
3. Incubate with secondary antibody conjugate, e.g. anti-mouse IgG (H+L) biotin-conjugated or fluorescein-conjugated.
4. Wash sample 3 times with PBST for 5 minutes each.
5. If a biotinylated secondary antibody was used, incubate with streptavidin-fluorescein (cat # 4800-30-14) diluted 1:300 in 1X PBS (or streptavidin coupled to fluorophore of choice).
6. Wash sample 3 times with PBST for 5 minutes each.
7. View under fluorescence microscope equipped with appropriate filters.
8. Counterstaining is possible using a dye that does not interfere with the fluorophore.

## XII. Troubleshooting Guide

### General Problems

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

PROBLEM	CAUSE	ACTION
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 75% viability. Decrease treatment with damaging agent.  Decrease electrophoresis time to 15-30 minutes.

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