SpermComet® Technology: A Deep Dive

Proprietary single-cell gel electrophoresis for clinical-grade sperm DNA damage detection and classification — built on 25+ years of peer-reviewed science.

Request an Assay

Download Technical Brief

Technology Identity

SpermComet® is a fully validated clinical service built on single-cell gel electrophoresis — the gold-standard comet assay methodology adapted for reproductive diagnostics. It delivers high-resolution assessment of sperm DNA integrity for clinical laboratories and reproductive medicine specialists.

Base Methodology

Single-cell gel electrophoresis (comet assay) for single-cell DNA strand integrity.

Application Domain

Sperm DNA damage detection and classification across three clinically actionable categories.

Academic Pedigree

25+ years of peer-reviewed research supporting the clinical framework.

IP Protection

Patent applications filed across multiple jurisdictions to protect proprietary innovations.

How the SpermComet® Assay Works

The SpermComet® assay is a five-stage clinical process that transforms a raw semen sample into a report detailing DNA fragmentation at single-cell resolution. Each stage is standardised for reproducibility, sensitivity, and clinical relevance across technicians, sample batches, and laboratory sites.

1

Sample Preparation

Isolate and embed sperm cells

2

DNA Unwinding

Alkaline treatment and electrophoresis

3

Fluorescence Visualisation

Stain and image individual comets

4

Comet Classification

Expert scoring of damage patterns

5

Report & Interpretation

Generate clinical report and guidance

Step 1: Sample Preparation

SpermComet® accepts both fresh and cryopreserved human semen samples, supporting use across IVF centres, andrology units, and remote collection sites. Rigorous preparation at intake ensures analytical validity and preserves the clinical context of DNA fragmentation findings.

01

Input Accepted

Fresh or cryopreserved human semen samples.

02

Quality Assessment

Volume, motility, and concentration measured at intake.

03

Cell Isolation

Sperm cells washed free of debris and leucocytes.

04

Slide Loading

Cells loaded at defined density onto agarose-coated slides.

Step 2: DNA Unwinding & Electrophoresis

Following slide loading, cells are lysed within an agarose gel matrix and subjected to alkaline unwinding, exposing the DNA for analysis. An electric field then separates intact from damaged DNA, with the extent of migration reflecting the degree of strand breakage.

Intact DNA Behaviour	Damaged DNA Behaviour
Remains tightly supercoiled near the nucleus, with minimal migration under the electric field. Produces a compact head with negligible tail extension.	Strand breaks relieve supercoiling constraints, allowing DNA to unwind and migrate toward the positive electrode. Tail length and intensity reflect damage severity.

Step 3: Visualisation & Fluorescence Imaging

Stained with SYBR Gold fluorescent dye, slides are imaged at high magnification under fluorescence microscopy. Strict quality controls ensure only valid cells proceed to classification.

400x

Minimum Magnification

Each cell imaged at 400x to 1000x for precise comet morphology capture.

500

Cells Per Sample

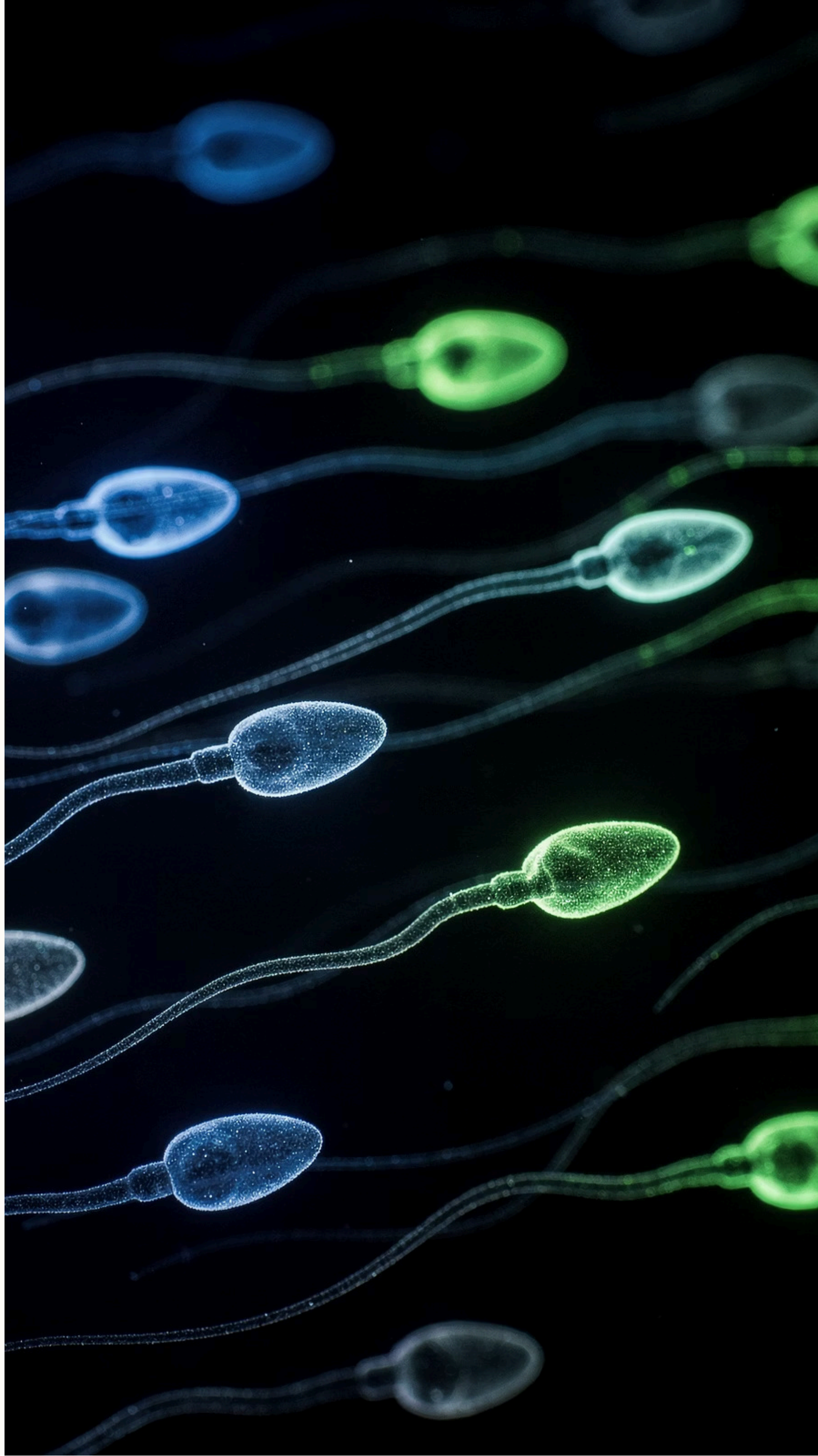
Up to 500 individual sperm cells analysed per sample for robust statistical confidence.

100–500

Cells Analysed

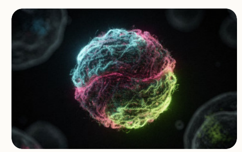
Per-sample cell count providing robust statistical confidence in fragmentation indices.

Cells that are overlapping, out of focus, or at the slide periphery are excluded — only those meeting defined morphological and positional criteria proceed to classification.



Step 4: Comet Pattern Classification — Examen's Key Differentiator

Classification is performed by highly trained scientists, not algorithms, who manually examine every imaged cell and assign it to a damage category. They apply adaptive, context-sensitive pattern recognition that no current algorithm reliably replicates.

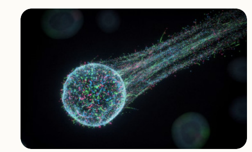


Class 0: Intact DNA

Tight nuclear sphere with minimal or absent tail extension. DNA remains fully compacted; no strand breaks detected. Classified as genetically healthy. **Clinical status: HEALTHY.**

Class 1: Single-Strand Breaks

Visible comet tail of moderate length. One strand of the DNA double helix is broken; the other remains intact. Often repairable by oocyte mechanisms. **Clinical status: DAMAGED BUT POTENTIALLY REPAIRABLE.**



Class 2: Double-Strand Breaks

Extensive tail with large migration distance. Both strands of the double helix are severed; DNA structure is fully unravelled. Irreparable by oocyte mechanisms. **Clinical status: CRITICALLY DAMAGED.**

Clinical Significance of Damage Class

The distinction between single-strand and double-strand DNA breaks carries profound clinical consequences that directly govern which therapeutic pathway is appropriate for the patient. Understanding this distinction is essential for treatment planning.

Class 1 — Single-Strand Breaks

Single-strand DNA breaks (ssDB) represent damage to only one strand of the double helix. Because the complementary strand remains intact, the damaged strand can serve as a template for repair. Crucially, the oocyte possesses base excision repair (BER) and nucleotide excision repair (NER) machinery capable of resolving these lesions post-fertilisation, particularly in younger women with high oocyte quality.

Therapeutic options include:

- Lifestyle modification: antioxidant supplementation, dietary improvement, exercise
- Medical treatment with targeted vitamins and micronutrient protocols
- Timed intercourse or IUI — viable when ssDB predominates
- Standard IVF techniques are acceptable

Class 2 — Double-Strand Breaks

Double-strand DNA breaks (dsDB) represent catastrophic structural failure. With both strands of the helix severed, the DNA molecule loses topological integrity entirely and cannot serve as a repair template. Oocyte repair mechanisms are insufficient to resolve dsDB at the frequency encountered in clinically significant cases, leading to a predictable cascade of adverse reproductive outcomes.

Clinical consequences:

- Fertilisation failure
- Embryo arrest at Day 1–2 post-fertilisation
- Implantation failure
- Early miscarriage and recurrent pregnancy loss

Mandatory therapeutic requirements: ICSI or Physiological ICSI (PICSI), sperm DNA fragmentation reduction programme, advanced embryo screening (PGT-A), and possible sperm donation consideration.

Step 5: Report Generation & Clinical Output Metrics

The SpermComet® report translates the single-cell classification data into a structured, actionable clinical output. It disaggregates total DFI into its constituent damage types so clinicians can calibrate therapeutic intensity with precision.

Total DFI %

Percentage of all sperm cells carrying any DNA damage — the headline metric for reproductive risk stratification and fertility treatment eligibility.

Single-Strand Breaks (ssDB) %

Proportion of cells with Class 1 damage. Informs probability of oocyte-mediated repair and guides suitability for IUI versus IVF versus ICSI.

Double-Strand Breaks (dsDB) %

Proportion of cells with Class 2 damage — the critical metric for predicting embryo arrest, implantation failure, and recurrent pregnancy loss risk.

High DNA Stainability (HDS) %

Proportion of cells exhibiting abnormal chromatin packaging — an indicator of immature sperm or incomplete nuclear condensation separate from strand break pathology.

Intact Cells (Class 0) %

Percentage of fully undamaged sperm — a positive prognostic indicator and direct complement to the DFI for contextualising overall sample quality.

What the Report Delivers

The SpermComet® clinical report is produced within 10–15 business days and is structured to meet the information needs of both the referring clinician and the patient.

It combines quantitative precision, visual evidence, and expert interpretation in a single clinical document.

Numerical results with validated clinical reference ranges

Immediate context for whether each index is within normal, borderline, or clinically significant parameters.

Representative fluorescence comet images per damage class

Visual evidence of the cell population driving the quantitative indices — supporting clinician confidence and patient communication.

Graphical damage distribution and longitudinal comparison

Population-level heterogeneity data and before/after treatment comparison where a prior baseline exists.

Integrated clinical recommendations

Evidence-based treatment planning guidance embedded within the report narrative — from lifestyle modification to mandatory ICSI or donor sperm pathways.

Turnaround Time: 10–15 business days from sample receipt. Both fresh and cryopreserved samples accepted. Contact Examen to discuss logistics for your laboratory or clinic.