## SUPPLEMENTARY INFORMATION LIST

**Supplementary Figures 1-12**

**Supplementary Note**

**Supplementary Videos 1-2**

**Supplementary Tables 1-3**

## SUPPLEMENTARY NOTE

### Description of rearrangement types identified using MSY/YqH FISH probes

Inter-chromosomal rearrangements comprised three categories: (1) *End-fusions* occurred when a complete copy of the Y chromosome joined a non-homologous chromosome in its entirety at or near the telomeres without the net loss of DNA sequence, which can produce a pseudodicentric chromosome. (2) *Translocations* occurred when a portion of the Y joined another chromosome at a distal region with deletion of the Y sequences that did not participate in the translocation event, the majority of which were non-reciprocal in nature. Because the MSY probe cannot distinguish the Yp arm from the proximal Yq arm, we considered a translocation to occur at Yp when the FISH signal nearest the translocation breakpoint hybridized to the euchromatic MSY portion of the Y chromosome, and conversely, to Yq when hybridized to the YqH probe. In contrast to translocations, (3) *insertions* occurred when a fragment of the Y joined an interstitial portion of another chromosome.

Intra-chromosomal rearrangements comprised four additional categories: (4) *Complex* patterns of rearrangements were observed in which the MSY/YqH FISH signals overlapped extensively, appeared highly diffused, and/or created ambiguous configurations wherein the breakpoints and rearrangement patterns were not easily discernible by microscopy. We predict a fraction of these to be chromothriptic in nature, which would require next-generation DNA sequencing to resolve. (5) Some derivative chromosomes were characterized by patterns that seemingly alternated between MSY/YqH signals, producing a banded appearance along the chromosomal axis. These rearrangements can either be explained by chromothripsis, or alternatively, by a series of *inversions* spanning the euchromatic MSY and YqH regions (see **Supplementary Fig. 5**). (6) *Isodicentrics* appeared as two copies of the Y fused to form a mirror-imaged duplication at either the Yp or Yq arm, a potential byproduct of sister chromatid recombination. Among all isodicentrics observed, none were joined at opposite Y arms (i.e., fusion between Yp/Yq ends). Lastly, (7) *deletions* occurred when one or both arms appeared truncated. The resolution of microscopy-based FISH permitted the detection of large, distal deletions, with small and/or internal deletions not readily visible.

## SUPPLEMENTARY DATA

**Supplementary Video 1 | Normal micronuclear envelope disassembly during mitosis.** Time-lapse imaging of DLD-1 lamin A–GFP cell entering mitosis with a micronucleus, indicated by a white arrow (6 minutes/frame, mean intensity projection). Note that the major nucleus and micronucleus undergoes concurrent nuclear envelope breakdown upon mitotic entry.

**Supplementary Video 2 | Aberrant micronuclear envelope disassembly during mitosis.** Time-lapse imaging of DLD-1 lamin A–GFP cell entering mitosis with a micronucleus, indicated by a white arrow (6 minutes/frame, mean intensity projection). Note that the micronucleus fails to undergo proper nuclear envelope breakdown throughout mitosis and persists into the subsequent cell cycle.

**Supplementary Table 1 | Summary of DLD-1 clones analysed by cytogenetics and whole-genome sequencing.**

**Supplementary Table 2 | Breakpoint junctions with microhomology or non-templated DNA insertion sequences.**

**Supplementary Table 3 | List of primer sequences.**