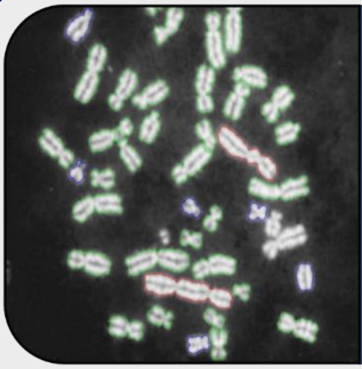
Automated Dicentric Chromosome Identifier and Dose Estimator

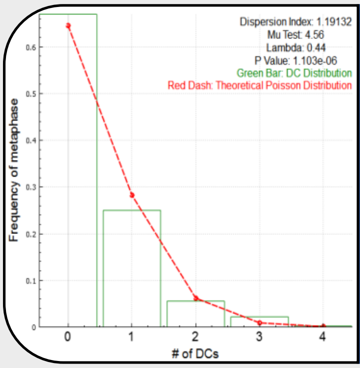
Dicentric chromosome biodosimetry is recommended by the International Atomic Energy Agency (IAEA) for occupational radiation exposure, radiation emergencies, or monitoring long term exposures. **In emergency responses to radiation exposures, laboratories need efficient methods to quantify dicentric chromosomes.** ADCI automates this with machine learning and image analysis.

ADCI finds centromeres and distinguishes monocentric and dicentric chromosomes with high sensitivity and specificity. It uses novel image segmentation to find and count dicentric chromosomes, then seamlessly estimates the radiation dose. As a complete cytogenetic biodosimetry system, ADCI fulfills the IAEA criteria for triage biodosimetry of a sample in less than an hour. Accuracies are comparable to experienced cytogeneticists.



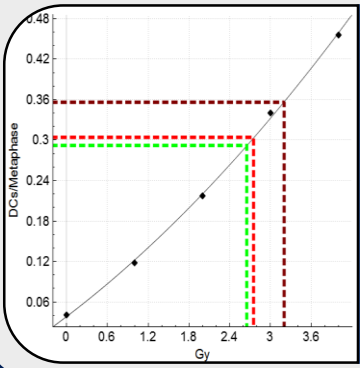
1. SELECTING OPTIMAL METAPHASE CELL IMAGES

ADCI can process a wide spectrum of chromosome structures, counts, and spacing. However, it performs best with a nearly complete complement of well-separated, linear chromosomes. A set of quality filters eliminates sub-optimal metaphase images before dicentric chromosomes (red outline) are counted.



2. FINDING DICENTRIC CHROMOSOMES

All chromosomes in an image are identified and the likely centromeres are delineated. Chromosomes are then classified by machine learning as either dicentric or monocentric. False positive dicentrics are removed. The dicentric chromosome frequency is calculated from all the images in a sample and fit to a Poisson distribution.



3. ESTIMATING RADIATION EXPOSURES

Dicentric chromosome frequencies of samples exposed to known doses are fit to a calibration curve (black line). Then, ADCI compares dicentric frequencies in samples of unknown dose (dotted lines) with the curve in order to estimate the radiation dose received (Gy).

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