Effects of Radiation on Chromosomes

Chromosome damage can be:

- morphologically visible, e.g., changes in number or structure
- or not visible but with functional consequences: mutations.

Methods of chromosome analysis:

- Standard staining after adding an agent that blocks mitosis in metaphase.

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- Banding techniques: various techniques to stain the chromosomes produce visible bands.
- Incorporation of [^{3}H]Thd followed by autoradiography.

Techniques to look at chromosome aberrations

Premature chromosome condensation:

- Irradiate cells
- Fuse irradiated cells with mitotic cells
- Factors in the mitotic cells **force** the chromosomes of the irradiated interphase cells to condense.
- This visualizes all damage including some that may have been repaired.
- Visualizes severe damage that may have been detected before mitosis and prevented the cell from entering mitosis.

Fluorescence in situ hybridization (FISH):
Uses fluorescently tagged chromosome probes (complimentary DNA) to specific chromosomes or regions of chromosomes.

Types of chromosome damage observed

- Terminal deletions
- Intrachromosome exchange
- Interchromosome exchange

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Chromosome aberrations and cell death

- Chromosome aberrations can be detected after doses as low as 0.1 Gy.
- Chromosome aberrations reflect both the initial damage and the repair. (misrepair), because the chromosomes are not visible until the cells enter mitosis.
- Doses in the 0.5 – 2 Gy range, produce on the average one chromosome aberration per cell.
- This dose range is, on the average, the mean lethal dose for cells.
- The frequency of chromosome aberrations is a linear quadratic function of radiation dose.
- There are considerable data showing a relationship between cell killing and the induction of chromosome aberrations.

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Historically, these led to the theory of dual radiation action.

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Cell cycle importance:

The state of the chromosomes affects the radiation sensitivity.

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