RADIATION THERAPY

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- Radiation therapy, also known as radiotherapy, is a medical treatment that uses ionizing radiation to kill or damage cancer cells. It is one of the primary modalities used in cancer treatment and relies on the principles of radiobiology to achieve therapeutic effects while minimizing damage to healthy tissues.

- In radiobiology, several key concepts underpin radiation therapy:

DNA Damage:

- Ionizing radiation interacts with molecules within cells, particularly DNA, leading to various forms of damage, including single-strand breaks, double-strand breaks, and cross-linking of DNA strands. These damages can disrupt the ability of cancer cells to replicate and survive.

Cellular Response to Radiation:

- Cells respond to radiation-induced DNA damage through various mechanisms, including repair, apoptosis (programmed cell death), or senescence (permanent growth arrest). The extent and type of response depend on factors such as the severity of DNA damage, the cell's repair capacity, and its stage in the cell cycle.

Radiation Sensitivity:

- As mentioned earlier, different types of cells exhibit varying degrees of sensitivity to radiation. Cancer cells, especially rapidly dividing ones, are generally more sensitive to radiation compared to normal cells. However, the goal of radiation therapy is to exploit these differences while minimizing damage to surrounding healthy tissues.

Fractionation:

- Radiation therapy is typically delivered in multiple fractions (smaller doses) over several days or weeks. Fractionation allows for the preferential killing of cancer cells while giving normal tissues time to repair and recover between treatments, thereby reducing the risk of toxicity.

Radiation Dose and Fractionation Schedules:

- The choice of radiation dose and fractionation schedule depends on factors such as tumor type, location, size, and overall patient health. Radiation oncologists carefully plan treatment regimens to maximize tumor control while minimizing adverse effects on normal tissues.

Radiation Delivery Techniques:

- Various techniques are used to precisely target radiation to the tumor while sparing nearby healthy tissues. These include external beam radiation therapy (EBRT), which delivers radiation from outside the body using machines such as linear accelerators, and brachytherapy, which involves placing radioactive sources directly into or near the tumor.

Radiation Biology of Hypoxia and Reoxygenation:

- Tumor hypoxia (low oxygen levels) can reduce the effectiveness of radiation therapy by limiting the generation of reactive oxygen species, which contribute to DNA damage. Strategies to overcome hypoxia, such as hyperbaric oxygen therapy or hypoxia-targeted radiosensitizers, aim to enhance the response of tumor cells to radiation.

- Overall, radiation therapy exploits the principles of radiobiology to selectively target and damage cancer cells while minimizing harm to normal tissues. Advances in radiobiological research continue to refine treatment strategies and improve outcomes for cancer patients undergoing radiation therapy.