Radiosensitization refers to the enhancement of the sensitivity of cancer cells to radiation therapy, resulting in increased effectiveness of radiation treatment in killing tumor cells. This approach is aimed at improving the therapeutic outcome of radiation therapy by either increasing the damage inflicted on cancer cells or reducing the radiation dose required to achieve a therapeutic effect, thus minimizing damage to surrounding healthy tissues.

There are several strategies employed for radiosensitization:

Chemical Agents: Certain drugs or compounds can sensitize cancer cells to the effects of radiation. These agents may interfere with DNA repair mechanisms, induce cell cycle arrest, or enhance the generation of reactive oxygen species, thereby increasing the susceptibility of cancer cells to radiation-induced DNA damage. Examples of radiosensitizing agents include cisplatin, 5-fluorouracil, gemcitabine, and cetuximab.

Targeted Therapy: Targeted agents that specifically inhibit molecular pathways involved in DNA repair, cell proliferation, or survival can enhance the radiosensitivity of cancer cells. For example, inhibitors of the epidermal growth factor receptor (EGFR), such as gefitinib and erlotinib, have been shown to radiosensitize tumors that overexpress EGFR.

Hypoxic Cell Sensitizers: Hypoxia, or low oxygen levels, is a common feature of solid tumors and can reduce the effectiveness of radiation therapy. Hypoxic cell sensitizers, such as nitroimidazoles, selectively sensitize hypoxic cancer cells to radiation by enhancing the generation of cytotoxic radicals under low-oxygen conditions.

Radiation Dose Fractionation: Altering the dose and fractionation schedule of radiation therapy can also enhance radiosensitivity. Hypofractionation, which delivers higher doses of radiation per fraction over a shorter overall treatment course, may exploit differences in DNA repair kinetics between cancer cells and normal tissues, leading to increased tumor cell kill.

Hyperthermia: Localized heating of tumors, known as hyperthermia, can sensitize cancer cells to radiation by increasing DNA damage, inhibiting DNA repair, and altering tumor microenvironmental factors. Hyperthermia is often used in conjunction with radiation therapy to enhance treatment efficacy.

Radioactive Sensitizers: Radioactive substances, such as iodine-131 or yttrium-90, can be combined with chemotherapy drugs and targeted to tumor sites, thereby delivering both radiation and chemotherapy directly to cancer cells, leading to increased cell kill.

Radiosensitization strategies are continually evolving, with ongoing research focused on identifying novel targets and combination therapies to maximize the therapeutic benefits of radiation therapy while minimizing side effects.