



FIGURE 4.44

Enhancement of the effects of ionizing radiation by oxygen.

### 11.1.1 External Beam Radiotherapy

This group of methods, also known as *teletherapy*, are the most common form of radiotherapy and involve the use of an external source of ionizing radiation that is pointed at the part of the body of the patient where the tumor is located. This ionizing radiation is normally applied in the form of X-rays, which arise from the impact of accelerated electrons striking a target, usually tungsten. They are classified according to the voltage employed to produce the photon beam into “superficial” (from a kilovolt source), employed for skin cancer, or “deep” (from a megavolt source), employed for deep-seated tumors. Some modern variations of this general technique are in use, such as *radiosurgery*, which involves the use of a high dose of externally generated radiation directed by three-dimensional imaging techniques (“stereotactic radiosurgery”) to eradicate tumors, normally in the brain or spine, without the need for conventional surgery. A detailed description of these and related techniques is outside the scope of this book.

### 11.1.2 Brachytherapy (Internal Radiation Therapy)

A radiation source is placed inside the body, at the site of the tumor, minimizing the exposure of healthy tissues to irradiation and allowing the use of high doses. In a variation known as *intraoperative radiotherapy*, the radiation source is applied to the tumor during surgery.

### 11.1.3 Radioisotope Therapy

This technique involves the systemic administration of radioisotopes, which need to be targeted to the tumor.<sup>115</sup> Radioisotopes employed in cancer therapy should have a relatively short half-life to avoid a prolonged effect on the patient, and they should emit radiation with a relatively short range. They normally belong to one of the following categories:

1.  $\beta^-$  emitters: Because  $\beta$  particles have spans of approximately 50 cell diameters, they are suitable for treating large or poorly vascularized tumors. On the other hand, their use to treat small tumors may damage nearby normal cells.
2.  $\alpha$  emitters are suitable for small tumors because  $\alpha$  particles have a very short range of approximately 10 cell diameters and are less harmful for surrounding tissue.
3. Nuclei emitting Auger electrons, which have an extremely short range of approximately one cell diameter and therefore require very precise targeting.