Recent technical advances in 3D conformal and intensity modulated radiotherapy (3DCRT and IMRT) based on patient-specific CT and MRI images, have the potential of delivering exquisitely conformal dose distributions to the target volume while avoiding critical structures. Emerging clinical results in terms of reducing treatment-related morbidity and increasing local control appear promising. Recent developments in imaging have suggested that biological images may further positively impact cancer diagnosis, characterization and therapy. While in the past radiological images are largely anatomical, the new types of images can provide metabolic, biochemical, physiological, functional and molecular (genotypic and phenotypic) information. For radiation therapy, images that give information about factors (e.g. tumor hypoxia, $T_{pot}$) that influence radiosensitivity and treatment outcome can be regarded as radiobiological images.

The ability of IMRT to "paint" (in 2D) or "sculpt" (in 3D) the dose, and produce exquisitely conformal dose distributions begs the "64 million dollar question" as to how to paint or sculpt, and whether biological imaging may provide the pertinent information. Can this new approach provide "radiobiological phenotypes" non-invasively, and incrementally improve upon the predictive assays of radiobiological characteristics such as proliferative activity ($T_{pot}$ – the potential doubling time), radiosensitivity ($SF_2$ – the surviving fraction at a dose of 2 Gy), energy status (relative to sublethal damage repair), pH (a possible surrogate of hypoxia), tumor hypoxia, etc. as prognosticator(s) of radiation treatment outcome. Important for IMRT, the spatial (geometrical) distribution of the radiobiological phenotypes provide the basis for dose distribution design to conform to both the physical (geometrical) and the biological attributes.