

Biology and Pathology

Cancer Biology

Imaging generic markers: proliferation, metabolism, angiogenesis, apoptosis

Michal Neeman

Biological Regulation, Weizmann Institute, Rehovot, Israel

Learning Objectives:

- Understand the significance of changes in proliferation, metabolism, angiogenesis, apoptosis in cancer
- Comprehend the strategies for imaging changes in proliferation, metabolism, angiogenesis, apoptosis
- Review the tools for validation of imaging biomarkers for proliferation, metabolism, angiogenesis, apoptosis

Cancer is a disease that is inherently characterized by very high heterogeneity, between patients, within a single patient, within a single tumor and also over time. Such heterogeneity implies that any information retrieved by invasive procedures based on biopsy are limited in their relevance for planning of therapy and monitoring disease progression. Clearly, non invasive tools and particularly non invasive imaging is critical for personalizing therapy. A number of generic markers show high relevance for characterization of many types of tumors and offer sensitive readout for effects of treatment. Among these, markers of cell proliferation and apoptosis provide critical information for tumor growth or regression, while imaging markers of metabolism and angiogenesis provide insight to the microenvironmental heterogeneity in tumors. Extensive progress in molecular imaging led to a wide range of contrast media for all imaging modalities, including optical, ultrasound, CT, MRI and PET.

Relevant Publications:

1. Hanahan, D. & Weinberg, R.A. Hallmarks of cancer: the next generation. *Cell* 144, 646-674 (2011).
2. Folkman, J. & Hanahan, D. Switch to the angiogenic phenotype during tumorigenesis. *Princess Takamatsu Symp* 22, 339-347 (1991).
3. Dvorak, H.F. Tumors: wounds that do not heal. Similarities between tumor stroma generation and wound healing. *N Engl J Med* 315, 1650-1659 (1986).
4. Carmeliet, P., et al. Role of HIF-1 α in hypoxia-mediated apoptosis, cell proliferation and tumour angiogenesis. *Nature* 394, 485-490 (1998).
5. Shweiki, D., Neeman, M., Itin, A. & Keshet, E. Induction of vascular endothelial growth factor expression by hypoxia and by glucose deficiency in multicell spheroids: implications for tumor angiogenesis. *Proc Natl Acad Sci U S A* 92, 768-772 (1995).

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