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Biophysical and neurophysiologic basis of functional MRI signal; animal models for functional MRI studies at high magnetic field; development of *in vivo* NMR methods for measuring oxygen consumption in brain; modeling oxygen transport into brain.

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PhD, Yale University, 1995
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Yale University:

E.K. Zavoisky Fund, International Society of Magnetic Resonance in Medicine
Young Scientist Award, International Society of Cerebral Blood Flow and Metabolism
Melvin H. Knisely Award, International Society of Oxygen Transport to Tissue
First Independent Research Support and Transition (FIRST) Award, National Institutes of Health
Development of Biological Instrument (DBI) Grants, National Science Foundation
Research Project (R01) Grants, National Institutes of Health
Pilot Research Grant, James S. McDonnell Foundation

Wabash College:

President's Scholarship Award, Wabash College
Lloyd and Howell Award in Chemistry, Wabash College
Oak Ridge Science Semester Fellow, Oak Ridge National Laboratory
PEW Undergraduate Science Fellow (at University of Rochester), James S. McDonnell Foundation
Sherman Clarke Fellow (declined), University of Rochester
Brown-Wetherhill Scholar (declined), Purdue University
Promotion of Research in Science, Sigma Xi
Outstanding Senior in Chemistry, Phi Lambda Upsilon
Outstanding Senior in Chemistry, The American Institute of Chemists Foundation

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The *Animal functional MRI Core* at the Yale Magnetic Resonance Research Center (MRRC) has four themes, all aimed at increasing the utility and interpretability of functional MRI as a reliable tool in experimental neuroscience for quantitative studies of brain structure and function. Although the main emphasis of the *Core* is towards development of NMR methods, other methods (e.g., electrophysiological and optical techniques) are being cultivated as well.

- 1) A major focus of the *Core* is quantitative characterization of biophysical and neurophysiologic events that contribute to the blood oxygenation level dependent (BOLD) functional MRI contrast. The focus here is to use multi-modal approaches (e.g., electrophysiological and optical techniques along with NMR methods) in rodent brain to probe the variety of events over a range of spatial and temporal scales to fully characterize the stimulation-induced dynamics of the fMRI signal.
- 2) A longstanding strength of the *Core* has been development of animal models for functional MRI studies at high magnetic field. Three sensory models have been developed for neurophysiologic studies of the rodent brain (i.e., forepaw, whisker, olfaction) and the current interest is to extend the BOLD spatial resolution to study neuronal architecture in mouse brain.
- 3) A major focus of the research at the Yale MRRC is the development of ^{13}C NMR methods to probe metabolism of natural substrates (e.g., ^{13}C -labeled glucose) in order to determine cellular energetics and function. The current interest of the *Core* is to extend the ^{13}C NMR spatial resolution to voxels smaller than a few μL (using chemical shift imaging methods at high speeds).
- 4) A direct necessity for quantitative characterization of the BOLD signal is to appropriately model oxygen transport from blood to the brain. Since the functional MRI community has prematurely embraced untested models which do not support trends observed *in vivo*, a major focus here is to obtain multi-modal data (over a range of spatial and temporal scales) so as to provide reliable inputs for a range of steady-state and dynamic models of oxygen transport.

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Selected publications:

Hyder F, Shulman RG, Rothman DL (1998) A model for the regulation of cerebral oxygen delivery *J Appl Physiol* 85:554-564

Hyder F, Renken R, Rothman DL (1999) In vivo carbon-edited detection with proton echo-planar spectroscopic imaging (ICED PEPSI): [3,4-¹³CH₂]glutamate/glutamine tomography in rat brain *Magn Reson Med* 42:997-1003

Hyder F, Kennan RP, Kida I, Mason GF, Behar KL, Rothman DL (2000) Dependence of oxygen delivery on blood flow in rat brain: A 7 Tesla nuclear magnetic resonance study *J Cereb Blood Flow Metab* 20:485-498

Kida I, Kennan RP, Rothman DL, Behar KL, **Hyder F** (2000) High-resolution CMR_{O₂} mapping in rat cortex: a multi-parametric approach to calibration of BOLD image contrast at 7 Tesla *J Cereb Blood Flow Metab* 20:847-860

Hyder F, Kida I, Behar KL, Kennan RP, Maciejewski PK, Rothman DL (2001) Quantitative functional imaging of the brain: Towards mapping neuronal activity by BOLD fMRI *NMR Biomed* 14:413-431

Smith AJ, Blumenfeld H, Behar KL, Rothman DL, Shulman RG, **Hyder F** (2002) Cerebral energetics and spiking frequency: The neurophysiological basis of fMRI *Proc Natl Acad Sci USA* 99:10765-10770

Hyder F, Rothman DL, Shulman RG (2002) Total neuroenergetics support localized brain activity: Implications for the interpretation of fMRI *Proc Natl Acad Sci USA* 99:10771-10776

Kida I, Xu F, Shulman RG, **Hyder F** (2002) Mapping at glomerular resolution: fMRI of rat olfactory bulb *Magn Reson Med* 48:570-576

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