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DR. ROBERT S. BALABAN

EDUCATION

POSITIONS

- 1980-1981 NATO Fellowship, Department of Biochemistry, University of Oxford, Oxford, UK. Advisors, Sir George Radda, Dr. Brian D. Ross.

1981-1982 Staff Fellow, Laboratory of Kidney and Electrolyte Metabolism, NHLBI, National Institutes of Health, Bethesda MD. Advisor, Jack Orloff, MD.

1982-1984 Senior Staff Fellow, Laboratory of Kidney and Electrolyte Metabolism, NHLBI, National Institutes of Health, Bethesda, MD.

1984-1987 Research Physiologist, Laboratory of Kidney and Electrolyte Metabolism, NHLBI, National Institutes of Health, Bethesda, MD.

1988-present Chief, Laboratory of Cardiac Energetics, NHLBI, National Institutes of Health, Bethesda, MD

1999-2005 Scientific Director, Laboratory Research Program, NHLBI, National Institutes of Health, Bethesda, MD.

2005-present Scientific Director, Division of Intramural Research, NHLBI, National Institutes of Health, Bethesda, MD.

PROFESSIONAL MEMBERSHIPS

- The American Physiological Society
 - The American Society of Cell Biology
 - The Biophysical Society
 - International Society for Magnetic Resonance in Medicine
 - Society for Cardiovascular Magnetic Resonance.

PROFESSIONAL ACTIVITIES

President, Society for Cardiovascular Magnetic Resonance. 2000-2002

President, International Society for Magnetic Resonance in Medicine. 1995-1996.

Associate Editor, American Journal of Physiology 1989-1994, 2008-present.

Editorial Boards: Circulation Research, Journal of Magnetic Resonance in Medicine, Journal of Cardiovascular Magnetic Resonance, Concepts in Magnetic Resonance and NMR in Biomedicine.

Series Editor: Current Topics in Membranes 2010-present

Various Scientific Advisory Boards for NIH, NRC, NSF, NIST, MRC (UK), MRC (Canada), MRC (Australia), ACC, and AHA.

AWARDS RECEIVED

Presidents Honor Role and Deans List, University of Miami

Duke University Graduate School Research Award

NIH Graduate Training Fellowship

North Carolina Heart Association Research Grant Recipient, 1979

Award for Excellence In Renal Research, American Physiological Society, 1981

Society of Magnetic Resonance in Medicine, Scientific Exhibit Award, 1989

R.M. Berne Lecture University of Virginia, 1990

Public Health Service Superior Service Award, 1993

Gold Medal, Society of Magnetic Resonance, 1994

Hoar Lecture in Biological Sciences, University of British Columbia, 1995

NIH Directors Award (Dr. Harold Varmus), 1998 and 1999

The G. Burroughs Mider Lecture, NIH, 2000

The Hounsfield Lecture, Imperial College, London, 2005

The Philip S. Chen Distinguished Lecture on Innovation and Technology Transfer, NIH, (2008)

NIH Directors Award (Dr. Francis Collins), 2010

PUBLICATIONS AND PATENTS

1. **Balaban, R. S.** The coupling of aerobic metabolism to active ion transport in the kidney. Duke University. *Dissertation*, 1979.
2. **Balaban, R.S., L.J. Mandel, and D.J. Benos.** On the cross-reactivity of amiloride and 2,4,6 triaminopyrimidine (TAP) for the cellular entry and tight junctional cation permeation pathways in epithelia. *J. Membr. Biol.* 49: 363-390, 1979.
3. **Balaban, R.S. and L.J. Mandel.** Comparison of the effects of increased intracellular calcium and antidiuretic hormone on active sodium transport in frog skin. A study with the calcium ionophore A23187. *Biochim. Biophys. Acta* 555: 1-12, 1979.
4. **Benos, D.J., L.J. Mandel, and R.S. Balaban.** On the mechanism of the amiloride-sodium entry site interaction in anuran skin epithelia. *J. Gen. Physiol.* 73: 307-326, 1979.
5. **Balaban, R.S., L.J. Mandel, S.P. Soltoff, and J.M. Storey.** Coupling of active ion transport and aerobic respiratory rate in isolated renal tubules. *Proc. Natl. Acad. Sci. U.S.A.* 77: 447-451, 1980.
6. **Balaban, R.S., S.P. Soltoff, J.M. Storey, and L.J. Mandel.** Improved renal cortical tubule suspension: spectrophotometric study of O₂ delivery. *Am. J. Physiol.* 238: F50-F59, 1980.
7. **Balaban, R.S. and L.J. Mandel.** Coupling of aerobic metabolism to active ion transport in the kidney. *J. Physiol. (Lond.)* 304: 331-348, 1980.
8. **Benos, D.J. and R.S. Balaban.** Energy requirements of the developing mammalian blastocyst for active ion transport. *Biol. Reprod.* 23: 941-947, 1980.
9. **Brazy, P.C., R.S. Balaban, S.R. Gullans, L.J. Mandel, and V.W. Dennis.** Inhibition of Renal Metabolism. Relative effects of arsenate on sodium, phosphate, and glucose transport by the rabbit proximal tubule. *J. Clin. Invest.* 66: 1211-1221, 1980.
10. **Harris, S.I., R.S. Balaban, and L.J. Mandel.** Oxygen consumption and cellular ion transport: evidence for adenosine triphosphate to O₂ ratio near 6 in intact cell. *Science* 208: 1148-1150, 1980.
11. **Balaban, R.S. and A.L. Sylvia.** Spectrophotometric monitoring of O₂ delivery to the exposed rat kidney. *Am. J. Physiol.* 241: F257-F262, 1981.
12. **Balaban, R.S., V.W. Dennis, and L.J. Mandel.** Microfluorometric monitoring of NAD redox state in isolated perfused renal tubules. *Am. J. Physiol.* 240: F337-F342, 1981.
13. **Balaban, R.S., D.G. Gadian, and G.K. Radda.** Phosphorus nuclear magnetic resonance study of the rat kidney in vivo. *Kidney Int.* 20: 575-579, 1981.
14. **Balaban, R.S., D.G. Gadian, G.K. Radda, and G.G. Wong.** An NMR probe for the study of aerobic suspensions of cells and organelles. *Anal. Biochem.* 116: 450-455, 1981.

15. **Harris, S.I., R.S. Balaban, L. Barrett, and L.J. Mandel.** Mitochondrial respiratory capacity and Na⁺- and K⁺-dependent adenosine triphosphatase-mediated ion transport in the intact renal cell. *J. Biol. Chem.* 256: 10319-10328, 1981.
16. **Mandel, L.J. and R.S. Balaban.** Stoichiometry and coupling of active transport to oxidative metabolism in epithelial tissues. *Am. J. Physiol.* 240: F357-F371, 1981.
17. **Balaban, R.S. and J.J. Blum.** Hormone-induced changes in NADH fluorescence and O₂ consumption of rat hepatocytes. *Am. J. Physiol.* 242: C172-C177, 1982.
18. **Balaban, R.S.** Nuclear magnetic resonance studies of epithelial metabolism and function. *Fed. Proc.* 41: 42-47, 1982.
19. **Balaban, R.S.** Non-invasive techniques for the investigation of renal metabolism and transport. In: *Biochemistry of the Kidney Functions*. edited by F. Morel. Amsterdam: Elsevier Biomedical Press, 1982, p. 337-352.
20. **Epstein, F.H., R.S. Balaban, and B.D. Ross.** Redox state of cytochrome aa₃ in isolated perfused rat kidney. *Am. J. Physiol.* 243: F356-F363, 1982.
21. **Lowry, M., R.S. Balaban, and B.D. Ross.** Effect of extracellular pH on the redox state of isolated rat renal cortical tubules as determined by fluorescence spectroscopy. *Contrib. Nephrol.* 31: 115-121, 1982.
22. **Balaban, R.S. and J.A. Ferretti.** Rates of enzyme-catalyzed exchange determined by two-dimensional NMR: a study of glucose 6-phosphate anomeration and isomerization. *Proc. Natl. Acad. Sci. U.S.A.* 80: 1241-1245, 1983.
23. **Balaban, R.S.** The application of nuclear magnetic resonance to the study of epithelial tissues. *Prog. Clin. Biol. Res.* 126: 73-86, 1983.
24. **Balaban, R.S. and J.A. Ferretti.** The use of 2D NMR to study enzyme reaction rates. *Trends in Analytical Chemistry* 3: 148-152, 1983.
25. **Balaban, R.S. and J.P. Bader.** The efficiency of (Na⁺ + K⁺)-ATPase in tumorigenic cells. *Biochim. Biophys. Acta* 730: 271-275, 1983.
26. **Balaban, R.S., H.L. Kantor, and J.A. Ferretti.** In vivo flux between phosphocreatine and adenosine triphosphate determined by two-dimensional phosphorous NMR. *J. Biol. Chem.* 258: 12787-12789, 1983.
27. **Balaban, R.S. and M.A. Knepper.** Nitrogen-14 nuclear magnetic resonance spectroscopy of mammalian tissues. *Am. J. Physiol.* 245: C439-C444, 1983.
28. **Benos, D.J. and R.S. Balaban.** Energy metabolism of preimplantation mammalian blastocysts. *Am. J. Physiol.* 245: C40-C45, 1983.
29. **Sariban-Sohraby, S., I.T. Magrath, and R.S. Balaban.** Comparison of energy metabolism in human normal and neoplastic (Burkitt's lymphoma) lymphoid cells. *Cancer Res.* 43: 4662-4664, 1983.

30. **Balaban, R.S.** The application of nuclear magnetic resonance to the study of cellular physiology. *Am. J. Physiol.* 246: C10-C19, 1984.
31. **Balaban, R.S. and J.P. Bader.** Studies on the relationship between glycolysis and (Na⁺ + K⁺)-ATPase in cultured cells. *Biochim. Biophys. Acta* 804: 419-426, 1984.
32. **Kantor, H.L., R.W. Briggs, and R.S. Balaban.** In vivo ³¹P nuclear magnetic resonance measurements in canine heart using a catheter-coil. *Circ. Res.* 55: 261-266, 1984.
33. **Kantor, H.L., J.A. Ferretti, and R.S. Balaban.** Kinetics of creatine phosphokinase and adenylate kinase. A two-dimensional NMR analysis. *Biochim. Biophys. Acta* 789: 128-135, 1984.
34. **Bagnasco, S., D. Good, R. Balaban, and M. Burg.** Lactate production in isolated segments of the rat nephron. *Am. J. Physiol.* 248: F522-F526, 1985.
35. **Benos, D.J., J.D. Biggers, R.S. Balaban, J.W. Mills, and E.W. Overstrom.** Developmental aspects of sodium-dependent transport processes of preimplantation rabbit embryos. *Soc. Gen. Physiol. Ser.* 39: 211-235, 1985.
36. **Cascio, H.E., R.S. Balaban, and P.D. Smith.** Composite video generation of an OMA vidicon detector. *Rev. Scientific Instruments* 56: 535-537, 1985.
37. **Kurtz, I. and R.S. Balaban.** Fluorescence emission spectroscopy of 1,4-dihydroxyphthalonitrile. A method for determining intracellular pH in cultured cells. *Biophys. J.* 48: 499-508, 1985.
38. **Bagnasco, S., R. Balaban, H.M. Fales, Y.M. Yang, and M. Burg.** Predominant osmotically active organic solutes in rat and rabbit renal medullas. *J. Biol. Chem.* 261: 5872-5877, 1986.
39. **Balaban, R.S.** Biological Applications of MR Spectroscopy. In: *Magnetic Resonance of the Reproductive System*, edited by S. McCarthy and F. Haseltine. NY: Slack Inc., 1986, p. 43-49.
40. **Balaban, R.S.** Non-Invasive approaches to studying renal metabolism in relation to active Na-transport. In: *Modern Techniques in Ion Transport*, edited by M. Dinno. NY: Churchill Livingston Inc, 1986, p. 91-104.
41. **Balaban, R. S., Kantor, H. L., and Ferretti, J. A.** ³¹P nuclear magnetic resonance studies of enzyme catalyzed rates of reaction in vitro and in vivo. 83-95. 1986. *6th Joint USA-USSR Symposium on Myocardial Metabolism*.
42. **Balaban, R.S., H.L. Kantor, L.A. Katz, and R.W. Briggs.** Relation between work and phosphate metabolite in the in vivo paced mammalian heart. *Science* 232: 1121-1123, 1986.
43. **Balaban, R.S., I. Kurtz, H.E. Cascio, and P.D. Smith.** Microscopic spectral imaging using a video camera. *J. Microsc.* 141: 31-39, 1986.
44. **Balaban, R.S., A.P. Koretsky, and L.A. Katz.** Loading Characteristics of surface coils constructed from wire and foil. *J. Magn. Reson.* 8: 556-560, 1986.
45. **Kantor, H.L., R.W. Briggs, K.R. Metz, and R.S. Balaban.** Gated in vivo examination of cardiac metabolites with ³¹P nuclear magnetic resonance. *Am. J. Physiol.* 251: H171-H175, 1986.

46. **Kupriyanov, V. V., Balaban, R. S., Steinschneider, A. Y., Lakomkin, V. L., Ruug, E. K., Smirnov, V. N., and Saks, V. A.** 31P-NMR study of the creatine kinase reaction mechanism in vitro and in vivo. 96-120. 1986. *6th Joint USA-USSR Symposium on Myocardial Metabolism*.
47. **Kupriyanov, V.V., J.A. Ferretti, and R.S. Balaban.** Muscle adenylate kinase catalyzes adenosine 5'-tetraphosphate synthesis from ATP and ADP. *Biochim. Biophys. Acta* 869: 107-111, 1986.
48. **Kurtz, I. and R.S. Balaban.** Ammonium as a substrate for Na⁺-K⁺-ATPase in rabbit proximal tubules. *Am. J. Physiol.* 250: F497-F502, 1986.
49. **Kurtz, I., R. Star, R.S. Balaban, J.L. Garvin, and M.A. Knepper.** Spontaneous luminal disequilibrium pH in S3 proximal tubules. Role in ammonia and bicarbonate transport. *J.Clin.Invest.* 78: 989-996, 1986.
50. **Veech, R.L., W.L. Gitomer, M.T. King, R.S. Balaban, J.L. Costa, and E.D. Eanes.** The effect of short chain fatty acid administration on hepatic glucose, phosphate, magnesium and calcium metabolism. *Adv. Exp. Med. Biol.* 194: 617-646, 1986.
51. **Bagnasco, S.M., S. Uchida, R.S. Balaban, P.F. Kador, and M.B. Burg.** Induction of aldose reductase and sorbitol in renal inner medullary cells by elevated extracellular NaCl. *Proc. Natl. Acad. Sci. U.S.A.* 84: 1718-1720, 1987.
52. **Balaban, R.S. and M.B. Burg.** Osmotically active organic solutes in the renal inner medulla. *Kidney Int.* 31: 562-564, 1987.
53. **Balaban, R.S., A. Koretsky, and L. Katz.** NMR investigations of cellular energy metabolism. *Ann. N.Y. Acad. Sci.* 508: 48-53, 1987.
54. **Hsieh, P.S. and R.S. Balaban.** 31P Imaging of *in vivo* creatine kinase reaction rates. *J. Magn. Reson.* 74: 574-579, 1987.
55. **Katz, L.A., A.P. Koretsky, and R.S. Balaban.** Respiratory control in the glucose perfused heart. A 31P NMR and NADH fluorescence study. *FEBS Lett.* 221: 270-276, 1987.
56. **Koretsky, A.P. and R.S. Balaban.** Changes in pyridine nucleotide levels alter oxygen consumption and extra-mitochondrial phosphates in isolated mitochondria: a 31P-NMR and NAD(P)H fluorescence study. *Biochim. Biophys. Acta* 893: 398-408, 1987.
57. **Koretsky, A.P., L.A. Katz, and R.S. Balaban.** Determination of pyridine nucleotide fluorescence from the perfused heart using an internal standard. *Am. J. Physiol.* 253: H856-H862, 1987.
58. **Lynch, R.M. and R.S. Balaban.** Energy metabolism of renal cell lines, A6 and MDCK: regulation by Na-K-ATPase. *Am. J. Physiol.* 252: C225-C231, 1987.
59. **Lynch, R.M. and R.S. Balaban.** Coupling of aerobic glycolysis and Na⁺-K⁺-ATPase in renal cell line MDCK. *Am. J. Physiol.* 253: C269-C276, 1987.

60. **Wolff, S.D. and R.S. Balaban.** Proton spectroscopy and imaging of the rabbit kidney, in vivo at 4.7Tesla. *J. Magn. Reson.* 75: 190-192, 1987.
61. **Balaban, R.S. and L.J. Mandel.** Metabolic substrate utilization by rabbit proximal tubule. An NADH fluorescence study. *Am. J. Physiol.* 254: F407-F416, 1988.
62. **Berkowitz, B.A., S.D. Wolff, and R.S. Balaban.** Detection of metabolites in vivo using 2D proton homonuclear correlated spectroscopy. *J. Magn. Reson.* 79: 547-553, 1988.
63. **Ewy, C.S., J.J. Ackerman, and R.S. Balaban.** Deuterium NMR cerebral imaging in situ. *Magn. Reson. Med.* 8: 35-44, 1988.
64. **Hsieh, P.S. and R.S. Balaban.** Saturation and inversion transfer studies of creatine kinase kinetics in rabbit skeletal muscle in vivo. *Magn. Reson. Med.* 7: 56-64, 1988.
65. **Katz, L.A., J.A. Swain, M.A. Portman, and R.S. Balaban.** Intracellular pH and inorganic phosphate content of heart in vivo: a 31P-NMR study. *Am. J. Physiol.* 255: H189-H196, 1988.
66. **Katz, L.A., A.P. Koretsky, and R.S. Balaban.** Activation of dehydrogenase activity and cardiac respiration: a 31P-NMR study. *Am. J. Physiol.* 255: H185-H188, 1988.
67. **Leon, M.B., D.Y. Lu, L.G. Prevosti, W.W.J. Macy, P.D. Smith, M. Granovsky, R.F. Bonner, and R.S. Balaban.** Human arterial surface fluorescence: atherosclerotic plaque identification and effects of laser atheroma ablation. *J. Am. Coll. Cardiol.* 12: 94-102, 1988.
68. **Nakanishi, T., R.S. Balaban, and M.B. Burg.** Survey of osmolytes in renal cell lines. *Am. J. Physiol.* 255: C181-C191, 1988.
69. **Portman, M.A., S. James, F.W. Heineman, and R.S. Balaban.** Simultaneous monitoring of coronary blood flow and 31P NMR detected myocardial metabolites. *Magn. Reson. Med.* 7: 243-247, 1988.
70. **Star, R.A., H. Nonoguchi, R. Balaban, and M.A. Knepper.** Calcium and cyclic adenosine monophosphate as second messengers for vasopressin in the rat inner medullary collecting duct. *J. Clin. Invest.* 81: 1879-1888, 1988.
71. **Wolff, S.D., C. Eng, and R.S. Balaban.** NMR studies of renal phosphate metabolites in vivo: effects of hydration and dehydration. *Am. J. Physiol.* 255: F581-F589, 1988.
72. **Balaban, R.S.** NMR Spectroscopy of the heart. Part 1. *Concepts Magn.Res.* 1: 15-26, 1989.
73. **Balaban, R.S. and F.W. Heineman.** Control of mitochondrial respiration in the heart in vivo. *Mol. Cell Biochem.* 89: 191-197, 1989.
74. **Balaban, R.S. and F.W. Heineman.** Interaction of oxidative phosphorylation and work in the heart, in vivo. *News in Physiol. Sciences* 4: 215-218, 1989.
75. **Balaban, R.S.** Experimental preparations and models for MRS. *Invest. Radiol.* 24: 948-950, 1989.
76. **Balaban, R.S.** MRS of the kidney. *Invest. Radiol.* 24: 988-992, 1989.

77. **Berkowitz, B.A. and R.S. Balaban.** Two-dimensional nuclear magnetic resonance studies of enzyme kinetics and metabolites in vivo. *Methods Enzymol.* 176: 330-334, 1989.
78. **Berkowitz, B.A. and R.S. Balaban.** Improvement in 31P NMR signal-to-noise for ATP in vivo using homonuclear decoupling. *Magn. Reson. Med.* 12: 249-252, 1989.
79. **Eng, J., R.M. Lynch, and R.S. Balaban.** Nicotinamide adenine dinucleotide fluorescence spectroscopy and imaging of isolated cardiac myocytes. *Biophys. J.* 55: 621-630, 1989.
80. **Fralix, T.A. and R.S. Balaban.** Magnetic resonance spectroscopy of the heart. *Curr. Opin. Radiol.* 1: 174-178, 1989.
81. **Fralix, T.A. and R.S. Balaban.** NMR Spectroscopy of the heart. Part II. *Concepts Magn. Res.* 1: 93-108, 1989.
82. **Katz, L.A., J.A. Swain, M.A. Portman, and R.S. Balaban.** Relation between phosphate metabolites and oxygen consumption of heart in vivo. *Am. J. Physiol.* 256: H265-H274, 1989.
83. **Koretsky, A.P., L.A. Katz, and R.S. Balaban.** The mechanism of respiratory control in the in vivo heart. *J. Mol. Cell Cardiol.* 21 Suppl 1: 59-66, 1989.
84. **Lim, K.O., S. Wolff, and R.S. Balaban.** Linear drive birdcage coil for 23Na human head studies at 1.5 T. *NMR. Biomed.* 2: 120-123, 1989.
85. **Portman, M.A., F.W. Heineman, and R.S. Balaban.** Developmental changes in the relation between phosphate metabolites and oxygen consumption in the sheep heart in vivo. *J. Clin. Invest.* 83: 456-464, 1989.
86. **Robbins, R.C., R.S. Balaban, and J.A. Swain.** Cerebroplegia protects the brain during two hours of circulation arrest. *Amer. Coll. Surgery.* 40: 266-267, 1989.
87. **Wolff, S.D., T.S. Stanton, S.L. James, and R.S. Balaban.** Acute regulation of the predominant organic solutes of the rabbit renal inner medulla. *Am. J. Physiol.* 257: F676-F681, 1989.
88. **Wolff, S.D., P.H. Yancey, T.S. Stanton, and R.S. Balaban.** A simple HPLC method for quantitating major organic solutes of renal medulla. *Am. J. Physiol.* 256: F954-F956, 1989.
89. **Wolff, S.D. and R.S. Balaban.** Magnetization transfer contrast (MTC) and tissue water proton relaxation in vivo. *Magn. Reson. Med.* 10: 135-144, 1989.
90. **Balaban, R.S. and L.J. Mandel.** Optical studies of cellular metabolism. In: *Non-Invasive Techniques in Cell Biology*, edited by K. Foskett and S. Grinstein. NY: Alan R. Liss, 1990, p. 213-236.
91. **Balaban, R. S.** The analysis of cardiac muscle energetics using phosphorous NMR spectroscopy. Lissner, J., Doppman, J. L., and Margulis, A. R. 271-274. 1990. *MR 89: Internationales Kernspintomographie Symposium.*
92. **Balaban, R.S.** Regulation of oxidative phosphorylation in the mammalian cell. *Am. J. Physiol.* 258: C377-C389, 1990.

93. **Benos, D.J. and R.S. Balaban.** Current topic: transport mechanisms in preimplantation mammalian embryos. *Placenta*. 11: 373-380, 1990.
94. **Berkowitz, B.A., T. Moriyama, H.M. Fales, R.A. Byrd, and R.S. Balaban.** In vivo metabolism of 3-deoxy-3-fluoro-D-glucose. *J. Biol. Chem.* 265: 12417-12423, 1990.
95. **Eng, J., B.A. Berkowitz, and R.S. Balaban.** Renal distribution and metabolism of [²H]choline. A ²H NMR and MRI study. *NMR. Biomed.* 3: 173-177, 1990.
96. **Fralix, T.A., F.W. Heineman, and R.S. Balaban.** Effects of tissue absorbance on NAD(P)H and Indo-1 fluorescence from perfused rabbit hearts. *FEBS Lett.* 262: 287-292, 1990.
97. **Griffith, P.K., M.G. Siegman, R.S. Balaban, T.L. Ceckler, R.E. Clark, and J.A. Swain.** Cerebral metabolism in the cyanotic animal: The effect of hypothermic cardiopulmonary bypass and circulatory arrest. *Am. Coll. Surgery Surgical Forum* 16: 208-210, 1990.
98. **Heineman, F.W. and R.S. Balaban.** Control of mitochondrial respiration in the heart in vivo. *Annu. Rev. Physiol.* 52: 523-542, 1990.
99. **Heineman, F.W. and R.S. Balaban.** Phosphorus-31 nuclear magnetic resonance analysis of transient changes of canine myocardial metabolism in vivo. *J. Clin. Invest.* 85: 843-852, 1990.
100. **Heineman, F.W., J. Eng, B.A. Berkowitz, and R.S. Balaban.** NMR spectral analysis of kinetic data using natural lineshapes. *Magn. Reson. Med.* 13: 490-497, 1990.
101. **Kupriyanov, V.V., R.S. Balaban, N.V. Lyulina, A.Y. Steinschneider, and V.A. Saks.** Combination of 31P-NMR magnetization transfer and radioisotope exchange methods for assessment of an enzyme reaction mechanism: rate-determining steps of the creatine kinase reaction. *Biochim. Biophys. Acta* 1020: 290-304, 1990.
102. **Robbins, R.C., R.S. Balaban, and J.A. Swain.** Intermittent hypothermic asanguineous cerebral perfusion (cerebroplegia) protects the brain during prolonged circulatory arrest. A phosphorus 31 nuclear magnetic resonance study. *J. Thorac. Cardiovasc. Surg.* 99: 878-884, 1990.
103. **Swain, J.A., R.C. Robbins, R.S. Balaban, T.J.J. McDonald, B. Schneider, and R.C. Groom.** The effect of cardiopulmonary bypass on brain and heart metabolism: a 31P NMR study. *Magn. Reson. Med.* 15: 446-455, 1990.
104. **Wolff, S. D. and Balaban, R. S.** Magnetization Transfer Contrast (MTC). Lissner, J, Doppman, J. L., and Margulis, A. R. 398-400. 1990. *MR 89: Internationales Kernspintomographie Symposium*.
105. **Wolff, S.D. and R.S. Balaban.** NMR imaging of labile proton exchange. *J. Magn. Reson.* 86: 164-169, 1990.
106. **Wolff, S.D., J. Eng, B.A. Berkowitz, S. James, and R.S. Balaban.** Sodium-23 nuclear magnetic resonance imaging of the rabbit kidney in vivo. *Am. J. Physiol.* 258: F1125-F1131, 1990.
107. **Wolff, S.D. and R.S. Balaban.** Regulation of the predominant renal medullary organic solutes in vivo. *Annu. Rev. Physiol.* 52: 727-746, 1990.

108. **Balaban, R.S., S. Chesnick, K. Hedges, F. Samaha, and F.W. Heineman.** Magnetization transfer contrast in MR imaging of the heart. *Radiology* 180: 671-675, 1991.
109. **Ceckler, T. and R.S. Balaban.** Tritium-proton magnetization transfer as a probe of cross relaxation in aqueous lipid bilayer suspensions. *J. Magn. Reson.* 93: 572-588, 1991.
110. **Ceckler, T.L., K. Karino, P.F. Kador, and R.S. Balaban.** Magnetic resonance imaging of the rabbit eye. Improved anatomical detail using magnetization transfer contrast. *Invest.Ophthalmol.Vis.Sci.* 32: 3109-3113, 1991.
111. **Eng, J., T.L. Ceckler, and R.S. Balaban.** Quantitative ¹H magnetization transfer imaging in vivo. *Magn. Reson. Med.* 17: 304-314, 1991.
112. **Fralix, T.A., T.L. Ceckler, S.D. Wolff, S.A. Simon, and R.S. Balaban.** Lipid bilayer and water proton magnetization transfer: effect of cholesterol. *Magn. Reson. Med.* 18: 214-223, 1991.
113. **Fralix, T.A., F.W. Heineman, and R.S. Balaban.** Effect of work on intracellular calcium of the intact heart. *Am J. Physiol.* 261: 54-59, 1991.
114. **Heineman, F.W. and R.S. Balaban.** Control of myocardial oxygen consumption by work. In: *The Heart and Cardiovascular System: Scientific Foundations*, edited by H.H. Fozard, E. Haber, R.B. Jennings, A.M. Katz, and H.E. Morgan. NY: Raven Press, 1991, p. 1641-1656.
115. **Karino, K., P.F. Kador, B. Berkowitz, and R.S. Balaban.** ¹⁹F NMR quantitation of lens aldose reductase activity using 3-deoxy-3-fluoro-D-glucose. *J. Biol. Chem.* 266: 20970-20975, 1991.
116. **Kim, D.K., F.W. Heineman, and R.S. Balaban.** Effects of beta-hydroxybutyrate on oxidative metabolism and phosphorylation potential in canine heart in vivo. *Am. J. Physiol.* 260: H1767-H1773, 1991.
117. **Knuttel, A. and R.S. Balaban.** A novel approach for the determination of fast exchange rate constants. *J. Magn. Reson.* 95: 309-319, 1991.
118. **Swain, J.A., T.J.J. McDonald, R.S. Balaban, and R.C. Robbins.** Metabolism of the heart and brain during hypothermic cardiopulmonary bypass. *Ann. Thorac. Surg.* 51: 105-109, 1991.
119. **Swain, J.A., T.J.J. McDonald, P.K. Griffith, R.S. Balaban, R.E. Clark, and T. Ceckler.** Low-flow hypothermic cardiopulmonary bypass protects the brain. *J. Thorac. Cardiovasc. Surg.* 102: 76-83, 1991.
120. **Swain, J.A., T.J.J. McDonald, R.C. Robbins, and R.S. Balaban.** Relationship of cerebral and myocardial intracellular pH to blood pH during hypothermia. *Am. J. Physiol.* 260: H1640-H1644, 1991.
121. **Wolff, S. and R.S. Balaban.** Application of ³²Na NMR to the study of the kidney. In: *Acute Renal Failure: Diagnosis, Treatment and Prevention*, edited by K. Solez and C. Racusen. NY: Marcel Dekker, 1991, p. 285-298.
122. **Wolff, S.D., S. Chesnick, J.A. Frank, K.O. Lim, and R.S. Balaban.** Magnetization transfer contrast: MR imaging of the knee. *Radiology* 179: 623-628, 1991.

123. Wolff, S.D., J. Eng, and R.S. Balaban. Magnetization transfer contrast: method for improving contrast in gradient-recalled-echo images. *Radiology* 179: 133-137, 1991.
124. Anderson, R.V., M.G. Siegman, R.S. Balaban, T.L. Ceckler, and J.A. Swain. Hyperglycemia increases cerebral intracellular acidosis during circulatory arrest *Ann.Thorac. Surg.* 54: 1126-1130, 1992.
125. Balaban, R.S. Patient safety during MRI and MRS. *Ann. N.Y. Acad. Sci.* 649: 335-337, 1992.
126. Balaban, R.S. and T.L. Ceckler. Magnetization transfer contrast in magnetic resonance imaging. *Magn. Reson. Q.* 8: 116-137, 1992.
127. Ceckler, T.L., S.D. Wolff, S.A. Simon, V. Yip, and R.S. Balaban. Dynamic and chemical factors affecting water proton relaxation by macromolecules. *J. Magn. Reson.* 98: 637-645, 1992.
128. Heineman, F.W., V.V. Kupriyanov, R. Marshall, T.A. Fralix, and R.S. Balaban. Myocardial oxygenation in the isolated working rabbit heart as a function of work. *Am. J. Physiol.* 262: H255-H267, 1992.
129. Laughlin, M.R., J.F. Taylor, A.S. Chesnick, and R.S. Balaban. Regulation of glycogen metabolism in canine myocardium: effects of insulin and epinephrine in vivo. *Am. J. Physiol.* 262: E875-E883, 1992.
130. Samaha, F.F., F.W. Heineman, C. Ince, J. Fleming, and R.S. Balaban. ATP-sensitive potassium channel is essential to maintain basal coronary vascular tone in vivo. *Am. J. Physiol.* 262: C1220-C1227, 1992.
131. Siegman, M.G., R.V. Anderson, R.S. Balaban, T.L. Ceckler, R.E. Clark, and J.A. Swain. Barbiturates impair cerebral metabolism during hypothermic circulatory arrest. *Ann. Thorac. Surg.* 54: 1131-1136, 1992.
132. Veres, Z., L. Tsai, T.D. Scholz, M. Politino, R.S. Balaban, and T.C. Stadtman. Synthesis of 5-methylaminomethyl-2-selenouridine in tRNAs: 31P NMR studies show the labile selenium donor synthesized by the seldD gene product contains selenium bonded to phosphorus. *Proc. Natl. Acad. Sci. U.S.A.* 89: 2975-2979, 1992.
133. Balaban, R.S. and F.W. Heineman. Nuclear magnetic resonance studies of myocardial metabolic responses to alterations in workload. In: *Cardiovascular Magnetic Resonance Spectroscopy*, edited by S. Schaefer and R.S. Balaban. Norwell: Kluwer Academic Publishers, 1993, p. 91-110.
134. Balaban, R.S. Experimental models in cardiac magnetic resonance spectroscopy. In: *Cardiovascular Magnetic Resonance Spectroscopy*, edited by S. Schaefer and R.S. Balaban. Norwell: Kluwer Academic Publishers, 1993, p. 11-23.
135. Heineman, F.W. and R.S. Balaban. Effects of afterload and heart rate on NAD(P)H redox state in the isolated rabbit heart. *Am.J.Physiol.* 264: H433-H440, 1993.
136. Kim, D.K., T.L. Ceckler, V.C. Hascall, A. Calabro, and R.S. Balaban. Analysis of water-macromolecule proton magnetization transfer in articular cartilage. *Magn. Reson. Med.* 29: 211-215, 1993.

137. **Laughlin, M.R., J. Taylor, A.S. Chesnick, M. DeGroot, and R.S. Balaban.** Pyruvate and lactate metabolism in the *in vivo* dog heart. *Am. J. Physiol.* 264: H2068-H2079, 1993.
138. **Scholz, T.D., T.L. Ceckler, and R.S. Balaban.** Magnetization transfer characterization of hypertensive cardiomyopathy: significance of tissue water content. *Magn. Reson. Med.* 29: 352-357, 1993.
139. **Turner, R., P. Jezzard, H. Wen, K.K. Kwong, D. Le Bihan, T. Zeffiro, and R.S. Balaban.** Functional mapping of the human visual cortex at 4 and 1.5 tesla using deoxygenation contrast EPI. *Magn. Reson. Med.* 29: 277-279, 1993.
140. **Balaban, R.S., J.F. Taylor, and R. Turner.** Effect of cardiac flow on gradient recalled echo images of the canine heart. *NMR. Biomed.* 7: 89-95, 1994.
141. **Ceckler, T.L. and R.S. Balaban.** Field dispersion in water-macromolecular proton magnetization transfer. *J. Magn. Reson. B.* 105: 242-248, 1994.
142. **Jezzard, P., F. Heineman, J. Taylor, D. DesPres, H. Wen, R.S. Balaban, and R. Turner.** Comparison of EPI gradient-echo contrast changes in cat brain caused by respiratory challenges with direct simultaneous evaluation of cerebral oxygenation via a cranial window. *NMR. Biomed.* 7: 35-44, 1994.
143. **Laughlin, M.R., J. Taylor, A.S. Chesnick, and R.S. Balaban.** Nonglucose substrates increase glycogen synthesis *in vivo* in dog heart. *Am. J. Physiol.* 267: H219-H223, 1994.
144. **Scholz, T.D. and R.S. Balaban.** Mitochondrial F1-ATPase activity of canine myocardium: effects of hypoxia and stimulation. *Am. J. Physiol.* 266: H2396-H2403, 1994.
145. **Wen, H., A.S. Chesnick, and R.S. Balaban.** The design and test of a new volume coil for high field imaging. *Magn. Reson. Med.* 32: 492-498, 1994.
146. **Wolff, S.D. and R.S. Balaban.** Magnetization transfer imaging: practical aspects and clinical applications. *Radiology* 192: 593-599, 1994.
147. **Balaban, R., P. Bottomley, T.R. Brown, D. Gadian, C. Mountford, G.K. Radda, B.D. Ross, R.G. Shulman, C. Springer, and K. Ugurbil.** Advances in physiological chemistry by *in vivo* NMR. A workshop sponsored by the Society of Magnetic Resonance held in Woods Hole, Massachusetts. *Magn. Reson. Med.* 34: 289-292, 1995.
148. **Balaban, R.S.** Personal Perspective on the History of NMR. In: *Encyclopedia of Nuclear Magnetic Resonance*, edited by C.J. Drayton. London: Wiley, 1995, p. 199-200.
149. **Balaban, R.S.** Magnetization transfer between water and macromolecules in proton MRI. In: *Encyclopedia of Nuclear Magnetic Resonance*, edited by C.J. Drayton. London: Wiley, 1995, p. 2962-2967.
150. **Duewell, S.H., T.L. Ceckler, K. Ong, H. Wen, F.A. Jaffer, S.A. Chesnick, and R.S. Balaban.** Musculoskeletal MR imaging at 4 T and at 1.5 T: comparison of relaxation times and image contrast. *Radiology* 196: 551-555, 1995.

151. **Jeppard, P. and R.S. Balaban.** Correction for geometric distortion in echo planar images from B0 field variations. *Magn. Reson. Med.* 34: 65-73, 1995.
152. **Mori, K., M.J. Lizak, T.L. Ceckler, R.S. Balaban, and P.F. Kador.** Magnetic resonance imaging of the galactosemic dog eye using magnetization transfer contrast. *Curr. Eye Res.* 14: 1035-1040, 1995.
153. **Ong, K.C., H. Wen, A.S. Chesnick, S. Duewell, F.A. Jaffer, and R.S. Balaban.** Radiofrequency shielding of surface coils at 4.0 T. *J. Magn. Reson. Imaging* 5: 773-777, 1995.
154. **Posse, S., C.A. Cuenod, R. Risinger, D. Le Bihan, and R.S. Balaban.** Anomalous transverse relaxation in ¹H spectroscopy in human brain at 4 Tesla. *Magn. Reson. Med.* 33: 246-252, 1995.
155. **Rosenstein, D.L., T.W. Ryschon, J.E. Niemela, R.J. Elin, R.S. Balaban, and D.R. Rubinow.** Skeletal muscle intracellular ionized magnesium measured by ³¹P-NMR spectroscopy across the menstrual cycle. *J. Am. Coll. Nutr.* 14: 486-490, 1995.
156. **Ryschon, T.W., M.D. Fowler, A.A. Arai, R.E. Wysong, S.B. Leighton, T.R.S. Clem, and R.S. Balaban.** A multimode dynamometer for in vivo MRS studies of human skeletal muscle. *J. Appl. Physiol.* 79: 2139-2147, 1995.
157. **Scholz, T.D., M.R. Laughlin, R.S. Balaban, V.V. Kupriyanov, and F.W. Heineman.** Effect of substrate on mitochondrial NADH, cytosolic redox state, and phosphorylated compounds in isolated hearts. *Am. J. Physiol.* 268: H82-H91, 1995.
158. **Scholz, T.D., R.F. Hoyt, J.R. DeLeonardis, T.L. Ceckler, and R.S. Balaban.** Water-macromolecular proton magnetization transfer in infarcted myocardium: a method to enhance magnetic resonance image contrast. *Magn. Reson. Med.* 33: 178-184, 1995.
159. **Balaban, R.S., V.K. Mootha, and A. Arai.** Spectroscopic determination of cytochrome c oxidase content in tissues containing myoglobin or hemoglobin. *Anal. Biochem.* 237: 274-278, 1996.
160. **Duewell, S., S.D. Wolff, H. Wen, R.S. Balaban, and P. Jeppard.** MR imaging contrast in human brain tissue: assessment and optimization at 4 T. *Radiology* 199: 780-786, 1996.
161. **Duewell, S., C.E. Kasserra, P. Jeppard, and R.S. Balaban.** Evaluation of methemoglobin as an autologous intravascular MRI contrast agent. *Magn. Reson. Med.* 35: 787-789, 1996.
162. **Jaffer, F.A., H. Wen, R.S. Balaban, and S.D. Wolff.** A method to improve the B0 homogeneity of the heart in vivo. *Magn. Reson. Med.* 36: 375-383, 1996.
163. **Jeppard, P., S. Duewell, and R.S. Balaban.** MR relaxation times in human brain: measurement at 4 T. *Radiology* 199: 773-779, 1996.
164. **Lizak, M.J., K. Mori, T.L. Ceckler, R.S. Balaban, and P.F. Kador.** Quantitation of galactosemic cataracts in dogs using magnetization transfer contrast-enhanced magnetic resonance imaging. *Invest. Ophthalmol. Vis. Sci.* 37: 2219-2227, 1996.

165. **Mootha, V.K., S. French, and R.S. Balaban.** Neutral carrier-based Ca(2+)-selective; microelectrodes for the measurement of tetraphenylphosphonium. *Anal. Biochem.* 236: 327-330, 1996.
166. **Ryschon, T.W., D.L. Rosenstein, D.R. Rubinow, J.E. Niemela, R.J. Elin, and R.S. Balaban.** Relationship between skeletal muscle intracellular ionized magnesium and measurements of blood magnesium. *J. Lab. Clin. Med.* 127: 207-213, 1996.
167. **Wen, H., F.A. Jaffer, T.J. Denison, S. Duewell, A.S. Chesnick, and R.S. Balaban.** The evaluation of dielectric resonators containing H₂O or D₂O as RF coils for high-field MR imaging and spectroscopy. *J. Magn. Reson. B.* 110: 117-123, 1996.
168. **Feinstein, J.A., F.H. Epstein, A.E. Arai, T.K. Foo, M.R. Hartley, R.S. Balaban, and S.D. Wolff.** Using cardiac phase to order reconstruction (CAPTOR): a method to improve diastolic images. *J. Magn. Reson. Imaging* 7: 794-798, 1997.
169. **Fowler, M.D., T.W. Ryschon, R.E. Wysong, C.A. Combs, and R.S. Balaban.** Normalized metabolic stress for 31P-MR spectroscopy studies of human skeletal muscle: MVC vs. muscle volume. *J. Appl. Physiol.* 83: 875-883, 1997.
170. **Jaffer, F.A., H. Wen, P. Jezzard, R.S. Balaban, and S.D. Wolff.** Centric ordering is superior to gradient moment nulling for motion artifact reduction in EPI. *J. Magn. Reson. Imaging* 7: 1122-1131, 1997.
171. **Mootha, V.K., A.E. Arai, and R.S. Balaban.** Maximum oxidative phosphorylation capacity of the mammalian heart. *Am. J. Physiol.* 272: H769-H775, 1997.
172. **Ryschon, T.W., M.D. Fowler, R.E. Wysong, A. Anthony, and R.S. Balaban.** Efficiency of human skeletal muscle in vivo: comparison of isometric, concentric, and eccentric muscle action. *J. Appl. Physiol.* 83: 867-874, 1997.
173. **Ryschon, T.W., J.C. Jarvis, S. Salmons, and R.S. Balaban.** High-energy phosphates and tension production in rabbit tibialis anterior/extensor digitorum longus muscles. *J. Appl. Physiol.* 82: 1024-1029, 1997.
174. **Singerman, R.W., T.J. Denison, H. Wen, and R.S. Balaban.** Simulation of B1 field distribution and intrinsic signal-to-noise in cardiac MRI as a function of static magnetic field. *J. Magn. Reson.* 125: 72-83, 1997.
175. **Song, A.W., S.D. Wolff, R.S. Balaban, and P. Jezzard.** The effect of off-resonance radiofrequency pulse saturation on fMRI contrast. *NMR. Biomed.* 10: 208-215, 1997.
176. **Wen, H., T.J. Denison, R.W. Singerman, and R.S. Balaban.** The intrinsic signal-to-noise ratio in human cardiac imaging at 1.5, 3, and 4 T. *J. Magn. Reson.* 125: 65-71, 1997.
177. **Wolff, S.D. and R.S. Balaban.** Assessing contrast on MR images. *Radiology* 202: 25-29, 1997.
178. **Balaban, R.S.** Physiological and biochemical information from water in cardiac MRI. In: *Current and future applications of magnetic resonance in cardiovascular disease*, edited by C.B. Higgins, J.S. Ingwall, and G.M. Pohost. Armonk: Futura Publishing Inc., 1998, p. 321-336.

179. **French, S.A., P.R. Territo, and R.S. Balaban.** Correction for inner filter effects in turbid samples: fluorescence assays of mitochondrial NADH. *Am. J. Physiol.* 275: C900-C909, 1998.
180. **Guivel-Scharen, V., T. Sinnwell, S.D. Wolff, and R.S. Balaban.** Detection of proton chemical exchange between metabolites and water in biological tissues. *J. Magn. Reson.* 133: 36-45, 1998.
181. **Wen, H. and R.S. Balaban.** Ultrasonic imaging of the electroacoustic effect in macromolecular gels. *Ultrason. Imaging* 20: 288-297, 1998.
182. **Wen, H., J. Shah, and R.S. Balaban.** Hall effect imaging. *IEEE Trans. Biomed. Eng.* 45: 119-124, 1998.
183. **Wiesler, D.G., H. Wen, S.D. Wolff, and R.S. Balaban.** Reduction of field of view in MRI using a surface-spoiling local gradient insert. *J. Magn. Reson. Imaging* 8: 981-988, 1998.
184. **Aletras, A.H., R.S. Balaban, and H. Wen.** High-resolution strain analysis of the human heart with fast-DENSE. *J. Magn. Reson.* 140: 41-57, 1999.
185. **Aletras, A.H., S. Ding, R.S. Balaban, and H. Wen.** DENSE: displacement encoding with stimulated echoes in cardiac functional MRI. *J. Magn. Reson.* 137: 247-252, 1999.
186. **Arai, A.E., C.C. Gaither, F.H. Epstein, R.S. Balaban, and S.D. Wolff.** Myocardial velocity gradient imaging by phase contrast MRI with application to regional function in myocardial ischemia. *Magn. Reson. Med.* 42: 98-109, 1999.
187. **Arai, A.E., C.E. Kasserra, P.R. Territo, A.H. Gandjbakhche, and R.S. Balaban.** Myocardial oxygenation in vivo: optical spectroscopy of cytoplasmic myoglobin and mitochondrial cytochromes. *Am. J. Physiol.* 277: H683-H697, 1999.
188. **Combs, C.A., A.H. Aletras, and R.S. Balaban.** Effect of muscle action and metabolic strain on oxidative metabolic responses in human skeletal muscle. *J. Appl. Physiol.* 87: 1768-1775, 1999.
189. **Gandjbakhche, A.H., R.F. Bonner, A.E. Arai, and R.S. Balaban.** Visible-light photon migration through myocardium in vivo. *Am. J. Physiol.* 277: H698-H704, 1999.
190. **Morgan, P.N., R.J. Iannuzzelli, F.H. Epstein, and R.S. Balaban.** Real-time cardiac MRI using DSP's [letter]. *IEEE Trans. Med. Imaging* 18: 649-653, 1999.
191. **Schulze, K., F.W. Heineman, H.P. Schultheiss, and R.S. Balaban.** Impairment of myocardial calcium homeostasis by antibodies against the adenine nucleotide translocator. *Cell Calcium* 25: 361-370, 1999.
192. **Wiesler, D.G., H. Wen, S.D. Wolff, and R.S. Balaban.** Improved field of view-reducing gradient insert: artifacts and application to cardiac imaging. *J. Magn. Reson. Imaging* 10: 209-215, 1999.
193. **Yang, Y., H. Wen, V.S. Mattay, R.S. Balaban, J.A. Frank, and J.H. Duyn.** Comparison of 3D BOLD functional MRI with spiral acquisition at 1.5 and 4.0 T. *Neuroimage*. 9: 446-451, 1999.

194. **Cannon, R.O. and R.S. Balaban.** Chest pain in women with normal coronary angiograms. *N. Engl. J. Med.* 342: 885-887, 2000.
195. **Dagher, A.P., A. Aletras, P. Choyke, and R.S. Balaban.** Imaging of urea using chemical exchange-dependent saturation transfer at 1.5T. *J. Magn. Reson. Imaging* 12: 745-748, 2000.
196. **Lizak, M.J., M.B. Datiles, A.H. Aletras, P.F. Kador, and R.S. Balaban.** MRI of the human eye using magnetization transfer contrast enhancement. *Invest. Ophthalmol. Vis. Sci.* 41: 3878-3881, 2000.
197. **Territo, P.R. and R.S. Balaban.** Rapid spectrophotometric determination of oxygen consumption using hemoglobin, in vitro: light scatter correction and expanded dynamic range. *Anal. Biochem.* 286: 156-163, 2000.
198. **Territo, P.R., V.K. Mootha, S.A. French, and R.S. Balaban.** Ca(2+) activation of heart mitochondrial oxidative phosphorylation: role of the F(0)/F(1)-ATPase. *Am. J. Physiol. Cell Physiol.* 278: C423-C435, 2000.
199. **Territo, P.R., S.A. French, M.C. Dunleavy, F.J. Evans, and R.S. Balaban.** Calcium activation of heart mitochondrial oxidative phosphorylation: Rapid kinetics of mVO₂, NADH and light scattering. *J. Biol. Chem.* 276:2586-2599, 2001.
200. **Ward, K.M., A.H. Aletras, and R.S. Balaban.** A new class of contrast agents for MRI based on proton chemical exchange dependent saturation transfer (CEST). *J. Magn. Reson.* 143: 79-87, 2000.
201. **Ward, K.M. and R.S. Balaban.** Determination of pH using water protons and chemical exchange dependent saturation transfer (CEST) *Magn. Reson. Med.* 44: 799-802, 2000.
202. **Combs, C. and R.S. Balaban.** Direct imaging of dehydrogenase activity within living cells using enzyme-dependent fluorescence recovery after photobleaching (ED- FRAP). *Biophysical J.* 80:2018-2028, 2001.
203. **French, S., C. Giulivi C., and R.S. Balaban.** Nitric oxide synthase in porcine heart mitochondria: Evidence for a low physiological activity. *Amer. J. Physiol. Heart Circ Physiol.* 280:H2863-2867, 2001.
204. **Territo, P.R., French, S.A., and R.S. Balaban.** Simulation of cardiac work transitions, in vitro: Effects of simultaneous calcium and ATPase additions on isolated porcine heart mitochondria. *Cell Calcium* 30:19-27, 2001.
205. **Smith, M.F., M.E. Daube-Witherspoon, P.S. Plascjak, L.P. Szajek, R.E. Carson, J.R. Everett, S.L. Green, P.R. Territo, R.S. Balaban, S.L. Bacharach, and W.C. Eckelman.** Device-dependent activity estimation and decay correction of radionuclide mixtures with application to Tc-94m PET studies. *Med Phys.* 28:36-45, 2001.
206. **Balaban, R.S., V.A. Hampshire.** Challenges in small animal noninvasive imaging. *Inst. Lab. Animal Res. J.* 42:248-262, 2001.

207. Weiss, C.R., A.E. Arai, M.N. Bui, Agyeman K.O., Waclawiw M.A., Balaban, R.S., R.O. Cannon 3rd. Arterial wall MRI characteristics are associated with elevated serum markers of inflammation in humans. *J Magn Reson Imaging.* 14:698-704, 2001.
208. Balaban, R.S., and A. Arai. Function, metabolic, and flow heterogeneity of the heart: the view is getting better. *Circ Res.* 88:265-267, 2001.
209. Epstein, F.H., J.F. London, D.C. Peters, L.M. Goncalves, K. Agyeman, J. Taylor, R.S. Balaban, and A.E. Arai. Multislice first-pass cardiac perfusion MRI: Validation in a model of myocardial infarction. *Magn. Reson. Med.* 47(3):482- 491, 2002.
210. Wasserman, B.A., W.I. Smith, H.H. Trout, 3rd, R.O. Cannon, 3rd, R.S. Balaban and Arai, A.E. Carotid Artery Atherosclerosis: In Vivo Morphologic Characterization with Gadolinium-enhanced Double-oblique MR Imaging Initial Results. *Radiology* 223(2):566-573, 2002.
211. Balaban, R.S. Cardiac energy metabolism homeostasis: role of cytosolic calcium. *J. Mol. Cell Cardiol.* 34(10):1259-71, 2002.
212. Decking, U.K., V.M. Pai, H. Wen, R.S. and Balaban. Does binding of Gd-DTPA to myocardial tissue contribute to late enhancement in a model of acute myocardial infarction? *Magn. Reson. Med.* 49(1):168-71, 2003.
213. Balaban, R.S., S. Bose, S.A. French, and P.R. Territo. Role of calcium in metabolic signaling between cardiac sarcoplasmic reticulum and mitochondria in vitro. *Am. J. Physiol. Cell Physiol.* 284(2):C285-93, 2003.
214. Kwong, R.Y., A.E. Schussheim, S. Rekhraj, A.H. Aletras, N. Geller, J. Davis, T.F. Christian, R.S. Balaban, and A.E. Arai. Detecting acute coronary syndrome in the emergency department with cardiac magnetic resonance imaging. *Circulation* 4;107(4):531-7, 2003.
215. Weiss, C.R., A.H. Aletras, J.F. London, J.L. Taylor, F.H. Epstein, R. Wassmuth, R.S. Balaban, and A.E. Arai. Stunned, infarcted, and normal myocardium in dogs: simultaneous differentiation by using gadolinium-enhanced cine MR imaging with magnetization transfer contrast. *Radiology* 226(3):723-30, 2003.
216. Hinds K.A., J.M. Hill, E.M. Shapiro, M.O. Laukkonen, A.C. Silva, C.A. Combs, T.R. Varney, R.S. Balaban, A.P. Koretsky, C.E. Dunbar. Highly efficient endosomal labeling of progenitor and stem cells with large magnetic particles allows magnetic resonance imaging of single cells. *Blood* 102:867-872, 2003.
217. Ward K., A.E. Schussheim, and R.S. Balaban. Contribution of Mitochondria to Cardiac Muscle Water/Macromolecule Proton Magnetization Transfer. *Mag. Res. Med.*, 50(6):1313-1316, 2003.
218. Bose S., S. French, F. A. Evans, F. Joubert, and R.S. Balaban. Metabolic network control of oxidative phosphorylation: multiple roles of inorganic phosphate. *J. Biol. Chem.* 278(40):39155-39165, 2003.

219. **Joubert F., H. M. Fales, H. Wen, C.A. Combs, and R.S. Balaban.** NADH enzyme-dependent fluorescence recovery after photobleaching (ED-FRAP): applications to enzyme and mitochondrial reaction kinetics, in vitro. *Biophys J.* 86(1):629-645, 2003.
- 220 **Callot, V., E. Bennett, U.K. Decking, R.S. Balaban, H. Wen.** In vivo study of microcirculation using the IVIM method dagger. *Magn Reson Med.* 50(3):531-540, 2003.
221. **Mammen, P.P., S.B. Kanatous, I.S. Yuhanna, P.W. Shaul, M.G. Garry, R.S. Balaban, D.J. Garry.** Hypoxia-Induced Left Ventricular Dysfunction in Myoglobin Deficient Mice. *Am. J. Physiol Heart Circ Physiol.* 285(5):H2132-H2141, 2003.
222. **Blinova, K., C.A. Combs, P. Kellman, R.S. Balaban.** Fluctuation Analysis of Mitochondrial NADH Fluorescence Signals in Confocal and 2-Photon Microscopy Images of Living Cardiac Myocytes. *J. Microscopy.* 213(1):70- 75, 2004.
223. **Kim, Y.O., S.J. Park, R.S. Balaban, M. Nirenberg, Y. Kim.** A functional genomic screen for cardiogenic genes using RNA interference in developing Drosophila embryos. *Proc. Natl. Acad. Sci. USA.* 101(1):159-64, 2004
224. **Combs, C.A., R.S. Balaban.** Enzyme-dependent fluorescence recovery after photobleaching of NADH: in vivo and in vitro applications to the study of enzyme kinetics. *Methods Enzymol.* 385:257-86, 2004.
225. **Decking U.K., V.M.,Pai , E. Bennett, J.L. Taylor, C.D. Fingas, K. Zanger, H. Wen, R.S. Balaban.** High-Resolution Imaging Reveals a Limit in the Spatial Resolution of Blood Flow Measurements by Microspheres. *Amer. J. Physiol. Heart Circ. Physiol.* 287(3):H1132-1140, 2004.
226. **Christian TF, Rettmann DW, Aletras AH, Liao SL, Taylor JL, Balaban RS, Arai AE.** Absolute myocardial perfusion in canines measured by using dual-bolus first-pass MR imaging. *Radiology.* 232(3):677-684, 2004.
227. **Blinova K, Carroll SM, Bose S, Smirnov AV, Harvey JJ, Knutson JR, Balaban RS.** The Distribution of Mitochondrial NADH Fluorescence Lifetimes: Steady State Kinetics of Matrix NADH Interactions. *Biochemistry* 44(7):2585-2594, 2005.
228. **Jobsis PD, Combs CA, Balaban RS.** Two-photon excitation fluorescence pH detection using 2, 3-Dicyanohydroquinone: A spectral ratiometric approach. *J. Microscopy* 217(3):260-264, 2005.
229. **Rothstein CE, Carroll SM, Combs CA, Jobsis PD, Balaban RS.** Skeletal muscle NAD(P)H two-photon fluorescence microscopy in vivo: topology and optical inner filters *Biophys. J.* 88(3):2165-2176, 2005.
230. **Balaban RS, Nemoto S, Finkel T.** Mitochondria, oxidants, and aging. *Cell* 120(4):483-495, 2005.
231. **Hogan MC, Stary CM, Balaban RS, Combs CA.** NAD(P)H fluorescence imaging of mitochondrial metabolism in contracting Xenopus skeletal muscle fibers: effect of oxygen availability. *Amer. J. Physiol.* 98(4):1420-1426, 2005

232. **Thompson RB, Aviles RJ, Faranesh AZ, Raman VK, Wright V, Balaban RS, McVeigh ER, Lederman RJ.** Measurement of skeletal muscle perfusion during post-ischemic reactive hyperemia using contrast-enhanced MRI with a step-input function. *Magn. Res. Med.* 54(2):289-298, 2005.
233. **Hopper RK, Carroll S, Aponte AM, Johnson DT, French S, Shen R-F, Witzmann FA, Harris RA, Balaban RS.** Mitochondria Matrix Phosphoproteome: Effect of Extramitochondrial Calcium. *Biochemistry* 45(8):2524-2536, 2006.
234. **Rothstein CE, Nauman M, Chesnick AS, Balaban RS.** Multi-photon excitation microscopy in intact animals. *J. Microscopy* 222(1):58-64, 2006.
235. **Balaban, RS.** Modeling mitochondrial function. *Am J Physiol Cell Physiol.* 291(6):C1107-1113, 2006.
236. **Schieke SM, Phillips D, McCoy JP, Aponte AM, Shen R-F, Balaban RS, Finkel T.** The mammalian target of rapamycin (mTOR) pathway regulates mitochondrial oxygen consumption and oxidative capacity. *J. Biol. Chem.* 281(37):27643-27652, 2006.
237. **Nemoto S, Combs CA, French S, Ahn BH, Fergusson MM, Balaban RS, Finkel T.** The mammalian longevity-associated gene product p66shc regulates mitochondrial metabolism. *J. Biol. Chem.* 281(15):10555-10560, 2006.
238. **Balaban RS.** Maintenance of the metabolic homeostasis of the heart: developing a systems analysis approach. *Ann N Y Acad Sci.* 1080:140-53, 2006.
239. **Johnson DT, Harris RA, French S, Blair PV, You J, Bemis K, Wang M, Balaban RS.** The Tissue Heterogeneity of the Mammalian Mitochondrial Proteome. *Am J Physiol Cell Physiol.* 292:689-697, 2007.
240. **Johnson DT, Harris RA, Blair PV, Balaban RS.** Functional Consequences of Mitochondrial Proteome Heterogeneity. *Am J Physiol Cell Physiol.* 292:698-707, 2007.
241. **Jobsis PD, Rothstein EC, Balaban RS.** Limited Utility of Acetoxymethyl (AM) Based Intracellular Delivery Systems, *in vivo*: Interference by Extracellular Esterases. *J. Microscopy* 226(1), 74-81, 2007.
242. **Territo PR, Heil, J, Bose, S., Evans, FJ, Balaban RS.** Fluorescence absorbance inner-filter decomposition: the role of emission shape on estimates of free Ca(2+) using Rhod-2. *Appl Spectrosc.* 61(2):138-47, 2007.
243. **Combs CA, Smirnov AV, Riley JD, Gandjbakhche AH, Knutson JR, Balaban RS.** Optimization of Multi-Photon Excitation Microscopy by Total Emission Detection (TED) Using a Parabolic Light Reflector. *J. Microscopy* 228(3):330-337, 2007.
244. **Jobsis, PD, Ashikaga, H, Wen H, Rothstein EC, Horvath KA, McVeigh ER, Balaban RS.** The visceral pericardium: macromolecular structure and contribution to passive mechanical properties of the left ventricle. *Am. J. Physiol Heart Circ Physiol* 293(6):H3379-H3387, 2007.
245. **Pagel-Langenickel I, Schwartz DR, Arena RA, Minerbi DC, Johnson DT, Waclawiw MA, Cannon RO 3rd, Balaban RS, Tripodi DJ, Sack MN.** A discordance in rosiglitazone mediated

insulin sensitization and skeletal muscle mitochondrial content/activity in Type 2 diabetes mellitus. *Am. J. Physiol. Heart Circ. Physiol.* 293(5):HH2659-H2666, 2007.

246. **Hsu LY, Wragg A, Anderson SA, Balaban RS, Boehm M, Arai AE.** Automatic assessment of dynamic contrast-enhanced MRI in an ischemic rat hindlimb model: an exploratory study of transplanted multipotent progenitor cells. *NMR Biomed.* 21(2):111-9, 2008

247. **Kwon GP, Schroeder BS, Amar MJ, Remaley AT, Balaban RS.** The contribution of macromolecular structure to the retention of LDL at arterial branch points. *Circulation.* 117(22):2919-27, 2008.

248. **Blinova K, Levine RL, Boja ES, Griffiths GL, Shi ZD, Ruddy B, Balaban RS.** Mitochondrial NADH fluorescence is enhanced by complex I binding. *Biochemistry.* 47(36):9636-45, 2008.

249. **Johnson DT, Harris RA, French S, Aponte AM, Balaban RS.** Proteomic Changes Associated with Diabetes in the BB-DP Rat. *Amer. J. Physiol. Endocrinology and Metabolism* 296(3):E422-32, 2009.

250. **Balaban RS.** Domestication of the cardiac mitochondrion for energy conversion. *J. Mol. Cell. Cardiol.* 46(6):832-841, 2009.

251. **Aponte AM, Phillips D, Harris RA, Blinova K, French S, Johnson DT, Balaban RS.** ³²P Labeling of protein phosphorylation and metabolite association in the mitochondrial matrix. *Methods in Enzymology,* 457:63-79, 2009.

252. **Aponte AM, Phillips D, Hopper RK, Johnson DT, Harris RA, Blinova K, Boja ES, French S, Balaban, RS.** Use of ³²P To Study Dynamics of the Mitochondrial Phosphoproteome. *J. Proteome Res.* 8(6), 2679-2695, 2009.

253. **Phillips D, Aponte AM, French SA, Chess, DJ, Balaban, RS.** Succinyl-CoA Synthetase is a phosphate target for the activation of mitochondrial metabolism. *Biochemistry.* 48(30): 7140-7149, 2009.

254. **Boja ES, Phillips D, French SA, Harris RA, Balaban RS.** Quantitative Mitochondrial Phosphoproteomics Using iTRAQ on an LTQ-Orbitrap with High Energy Collision Dissociation. *J. Proteome Res.* 8(10):4664-4675, 2009.

255. **Balaban RS.** The role of Ca²⁺ signaling in the coordination of mitochondrial ATP production with cardiac work. *Biochem. Biophys. Acta.* 1787(11):1334-1341, 2009.

256. **Park J-Y, Wang P-Y, Matsumoto T, Sung HJ, Ma W, Choi JW, Anderson SA, Leary SC, Balaban RS, Kang j-G, Wang PM.** p53 Improves aerobic exercise capacity and augments skeletal muscle mitochondria DNA content. *Circ. Res.* 105(7):705-712, 2009.

257. **Phillips D, Ten Hove M, Schneider JE, Wu CO, Sebag-Montefiore L, Aponte AM, Lygate CA, Wallis J, Clarke K, Watkins H, Balaban RS, Neubauer S.** Mice over-expressing the myocardial creatine transporter develop progressive heart failure and show decreased glycolytic capacity. *J. Mol. Cell. Cardiol.* 48(4):582-590, 2010.

258. **Schroeder JL, Luger-Hamer M, Pursley R, Pohida T, Chefd'Hotel C, Kellman P,**

Balaban RS. Subcellular motion compensation for minimally invasive microscopy, *in vivo*. Evidence for oxygen gradients in resting muscle. *Circ. Res.* 106(6):1129-1133, 2010.

259. **Neufeld EB, Yu Z-Y, Springer D, Yu Q, Balaban RS.** The renal artery ostium flow diverter: Structure and potential role in atherosclerosis. *Atherosclerosis*, 211(1), 153-158, 2010.

260. **Eagle KA, Ginsburg GS, Musunuru K, Aird WC, Balaban RS, Bennett SK, Blumenthal RS, Coughlin SR, Davidson KW, Frohlich ED, Greenland P, Jarvik GP, Libby P, Pepine CJ, Ruskin JN, Stillman AE, Van Eyk JE, Tolunay HE, McDonald CL, Smith SC.** Identifying Patients at High Risk of a Cardiovascular Event in the Near Future: Current Status and Future Directions: Report of a National Heart, Lung, and Blood Institute Working Group. *Circulation* 121:1447-1454, 2010.

261. **Phillips D, Reiley MJ, Aponte AM, Wang G, Boja E, Gucek M, Balaban RS.** Stoichiometry of STAT3 and Mitochondrial Proteins: Implications for the Regulation of Oxidative Phosphorylation by Protein-Protein Interactions. *J. Biol. Chem.* 285: 23532-23536, 2010.

262. **Combs CA, Smirnov A, Chess D, McGavernDB, Schroeder JL, Riley J, Kang SS, Luger-Hamer A, Gandjbakche A, Knutson JR, Balaban RS.** Optimizing multiphoton fluorescence microscopy light collection from living tissues by noncontact total emission detection (epiTED). *J. Microscopy* 241(2):153-161, 2011.

Perspective in SCIENCE 331:1016-1017, 2011

263. **Balaban RS.** The mitochondrial proteome: A dynamic functional program in tissues and disease states. *Environmental and Molecular Mutagenesis* 51(5):352-359, 2010.

264. **Glancy B, Balaban RS.** Protein Composition and Function of Red and White Skeletal Muscle Mitochondria. *Amer. J. Physiol. Cell Physiol.* (in press) 2011.

265. **Phillips D, Aponte A, Covian-Garcia R, Balaban RS.** Intrinsic Protein Kinase Activity in Mitochondrial Oxidative Phosphorylation Complexes. *Biochemistry* (in press) 2011.

U.S. Patents:

1. Local magnetization spoiling using a gradient insert for reducing the field of view in magnetic resonance imaging. 6,384,601 D. Wiesler, H. Wen, S.D. Wolff, and R.S.Balaban.

2. MRI coil using inductively coupled individually tuned elements arranged as free-pivoting components. 5,483,163 H. Wen and R.S. Balaban

3. Electro-acoustic Imaging Methods and Apparatus. 6,645,144 H. Wen and R.S. Balaban.

4. Magnetization transfer contrast and proton relaxation and use thereof in magnetic resonance imaging. 5,050,609 Wolff, S.D. and R.S. Balaban
5. MRI contrast agents depending on proton chemical exchange. K. Ward, A. Aletras and R.S. Balaban. (Pending)
6. Ultrasound array and electrode array for Hall Effect Imaging. H .Wen, and R.S. Balaban (Pending)