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B. Chance, C. D'Ambrosia, J. S. Leigh, Jr. and G. McDonald

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In vivo and freeze-trapped assays of the energy state of brain and skeletal tissues

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By B. Chance, C. D'Ambrosia, J. S. Leigh Jr and G. McDonald
Johnson Research Foundation, University of Pennsylvania, Philadelphia, U.S.A.

Non-invasive, non-destructive assay of energy-related metabolic activity of body tissues is the goal of several biophysical approaches, surface fluorometry of mitochondrial flavoprotein, positron emission tomography and ^{31}P n.m.r. Each has an appropriate specificity, time range, resolution and tissue damage potential. ^{31}P n.m.r. is the least invasive and at 72 MHz, with a 20 min averaging time and a 20 mm bore magnet, it affords *in vivo* assay of energy related compounds of tissues in small animals, such as fish skeletal muscle (loach) and heads of adult mouse and of newborn gerbils. In the transition from normoxia and nitrogen anoxia, decreases of the creatine phosphate : inorganic phosphate ratios from 3.9, 5.0, 2.7 in normoxia to 1.2, 0.04, 0.06 in anoxia occur in fish, mouse and gerbil respectively. The remarkable retention of significant ATP levels (80% of normoxic) in the new-born gerbil through 20 min of N_2 anoxia is clearly demonstrated. Evidence for the origin of much of the *in vivo* signal from the mouse brain is afforded by the fast freeze-trapping, excision of brain and assay by cryo-n.m.r. (Chance, B. *et al.* 1978 *Proc. natn. Acad. Sci. U.S.A.* **75**, 4925–4929) at -12 °C, the lowest temperature at which tissue signals are observed.