

## Publication

Ascorbic acid, a vitamin, is observed by in vivo  $^{13}\text{C}$  nuclear magnetic resonance spectroscopy of rat liver

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The first in vivo detection of a vitamin with nuclear magnetic resonance (NMR) is reported for mammalian liver. Vitamin C, also known as ascorbic acid, was monitored noninvasively in rat liver by "whole body"  $^{13}\text{C}$  NMR spectroscopy at high field after infusion of  $[1,2-^{13}\text{C}_2]$ glucose into anesthetized rats. Generally, the carbon resonances of ascorbic acid overlap with those of other highly abundant cellular metabolites, thus precluding their observation in situ. This problem was resolved by taking advantage of the  $^{13}\text{C}$ - $^{13}\text{C}$  spin couplings introduced by the two covalently bound  $^{13}\text{C}$  nuclei in  $[1,2-^{13}\text{C}_2]$ glucose. During glucose metabolism,  $[5,6-^{13}\text{C}_2]$ ascorbic acid was synthesized, which also exhibited characteristic  $^{13}\text{C}$  homonuclear spin couplings. This feature enabled the spectral discrimination of ascorbic acid from overlapping singlet resonances of other metabolites. Quantitative analysis of the spin-coupling patterns provided an estimate of the turnover rate of hepatic ascorbic acid in vivo ( $1.9 \pm 0.4 \text{ nmol} \cdot \text{min}^{-1} \cdot \text{g}^{-1}$ ) and a novel approach toward a better understanding of optimal ascorbic acid requirements in humans. The results obtained in vivo were confirmed with high-resolution proton and  $^{13}\text{C}$  NMR spectroscopy of liver extracts.

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