

# USANA Technical Bulletin

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## Choline

### Technical Background

- Choline is an important nutrient synthesized by the body and necessary for the function of every cell.<sup>1</sup>
- Choline plays a major role in metabolism, membrane structure and integrity, lipid and cholesterol transport, and brain function. Choline is the major component of acetylcholine, a neurotransmitter in the brain.
- It has been shown that reduced levels of acetylcholine may lead to reduced memory. Whether or not choline supplementation enhances memory is still a matter of debate. Several studies have found that rats exposed to high levels of choline in the womb have larger and more efficient cells in the hippocampus (the region of the brain associated with memory), and display life-long memory enhancement.<sup>1,2</sup> Similar studies have not, however, been completed on humans.
- Free choline can directly cross the blood-brain barrier by a choline-specific transport system.<sup>3</sup> Because choline must be transported across this barrier, high plasma levels do not necessarily indicate that the levels in the brain are also adequate.
- In addition to memory reduction, there is evidence that choline deficiency contributes to liver dysfunction.<sup>4</sup> In animals, choline deficiency is associated with an increased incidence of liver cancer.<sup>5</sup>

### Sources and Recommended Intake

- Choline has recently been identified as an essential nutrient, and recommended minimum daily intake levels have been set at 550mg/day for men, 425 mg/day for women, 450 mg/day for pregnant women, and 550 mg/day for lactating women.<sup>6</sup>
- Foods with the highest concentrations of choline are beef liver, chicken liver, eggs,<sup>1</sup> milk, and peanuts.
- The major dietary source of choline is lecithin. Lecithin is a choline phosphatidase; free choline is only found in small quantities. Lecithin must be broken down into components by enzymatic hydrolysis.
- Choline levels in the plasma can be maintained with adequate diet or supplements. Choline levels circulating in the brain decrease with increasing age. Deficiency may be due to decreased uptake of choline in the brain.<sup>7</sup>
- There have been no reported toxic reactions associated with choline.

## Abstracts

**Zeisel SH. Nutritional importance of choline for brain development. *J Am Coll Nutr.* 2004 Dec;23(6 Suppl):621S-626S.** Choline is a dietary component essential for normal function of all cells. In 1998 the National Academy of Sciences, USA, issued a report identifying choline as a required nutrient for humans and recommended daily intake amounts. In ongoing studies we are finding that men have a higher requirement than do postmenopausal women, who in turn need more than premenopausal women. Pregnancy and lactation are periods when maternal reserves of choline are depleted. At the same time, the availability of choline for normal development of the brain is critical. When rat pups received choline supplements (in utero or during the second week of life), their brain function is changed, resulting in lifelong memory enhancement. This change in memory function appears to be due to changes in the development of the memory center (hippocampus) in brain. These changes are so important that investigators can pick out the groups of animals whose mothers had extra choline even when these animals are elderly. Thus, memory function in the aged is, in part, determined by what mother ate. Foods highest in total choline concentrations per 100 g were beef liver (418 mg), chicken liver (290 mg), and eggs (251 mg). We suggest that choline-rich foods are an important component of the diet and that especially during pregnancy it would be prudent to include them as part of a healthy diet.

## References

- <sup>1</sup> Zeisel SH. Nutritional importance of choline for brain development. *J Am Coll Nutr.* 2004 Dec;23(6 Suppl):621S-626S.
- <sup>2</sup> Glenn MJ, Gibson EM, Kirby ED, Mellott TJ, Blusztajn JK, Williams CL. Prenatal choline availability modulates hippocampal neurogenesis and neurogenic responses to enriching experiences in adult female rats. 2007. *Eur Jour Neuroscience* 25(8):2473-2482.
- <sup>3</sup> Groff JL, Gropper SS, Hunt SM. *Advanced Nutrition and Human Metabolism.* 2<sup>nd</sup> ed. New York:West Publishing CO;1995. p 493.
- <sup>4</sup> Zeisel SH. Choline: an important nutrient in brain development, liver function and carcinogenesis. *J Am Coll Nutr.* 1992 Oct;11(5):473-81.
- <sup>5</sup> Newberne PM, Rogers AE. 1986. Labile methyl groups and the promotion of cancer. *Annu Rev Nutr* 6:407-432.
- <sup>6</sup> Institute of Medicine. *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline.* Washington, D.C.: National Academy Press. 1998: 390-422.
- <sup>7</sup> Cohen BM, Renshaw PF, Stoll AL, Wurtman RJ, Yurgelun-Todd D, Babb SM. Decreased brain choline uptake in older adults. An in vivo proton magnetic resonance spectroscopy study. *JAMA* 1995 Sep 20 274(11):902-7.