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Nutrition and brain development

(DHA, choline & lutein)

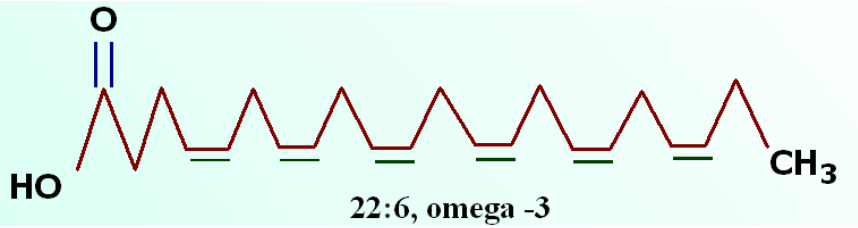
October 2019

GM

Presentation overview

- DHA, lutein and Choline
  - In breast milk
  - In brain and eye
  - Scientific evidence

DHA in breast milk



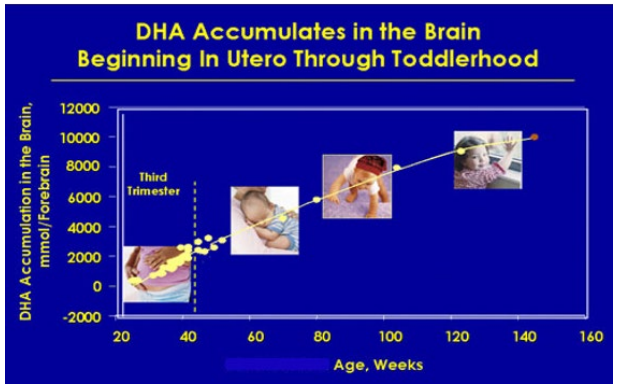
- An omega-3 long-chain polyunsaturated fatty acid, DHA is found in human milk at levels ranging between 0.17% to 0.99% of the total fatty acids (FAs)[1]
- It been estimated that the global mean DHA levels in human milk is ~0.32% of total FAs[2]

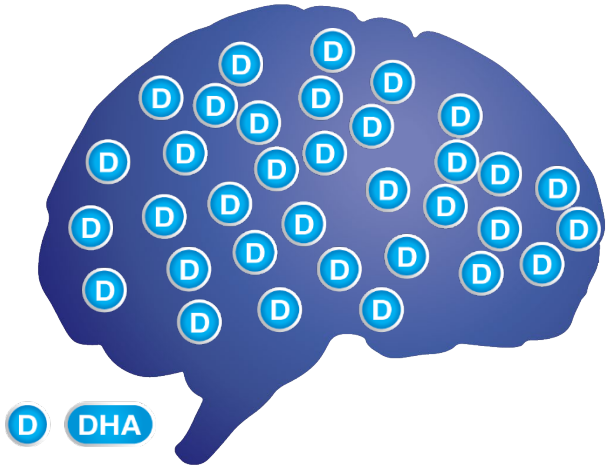
Breastfed infants DHA intake varies, given that the levels in the human milk are dependent on the mother's diet[1]

1. Yuhas et al., 2006;
2. Brenna et al., 2007

DHA and brain

- Accumulation is high during the 3rd trimester and by birth, it's the predominant fatty acid in brain
  - The accumulation acceleration continues through to 2nd year of life[1, 2]



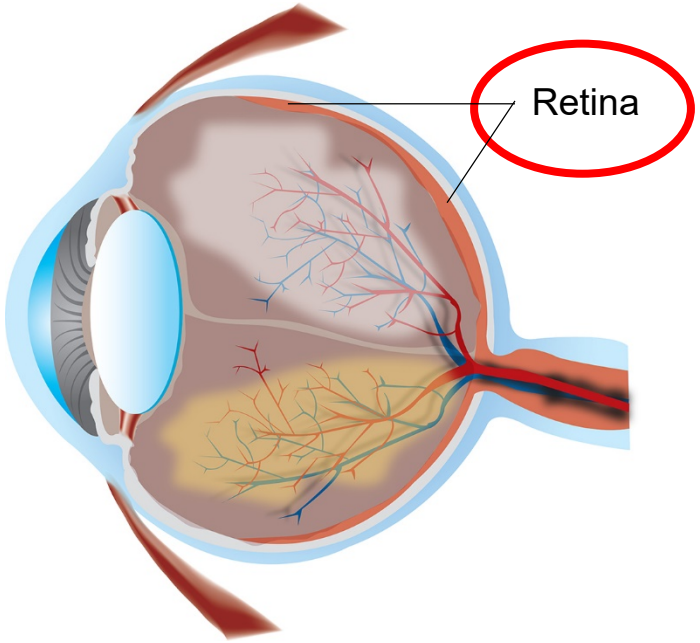


- DHA is a structural building block of cell membranes in the brain
  - The accumulation acceleration continues through to 2nd year of life[1, 2]

1. Martinez M., 1992
2. Clandinin et al., 1980
3. McCormick D., 1993
4. FAO 2010

DHA and eye

- DHA is a predominant fatty acid in the retina[1]



- ~50% of all fatty acids in retina - photoreceptor cells is DHA[2]
- In the retina DHA accumulation is essential for maturation & optimal visual function[1]

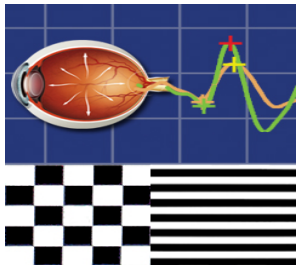
1. Lien &Hammond 2011
2. Anderson et al., 1974

Scientific evidence on DHA

Bayley Scales of Infant and Toddler Development™ THIRD EDITION

- Clinically DHA has been demonstrated to impact both brain and visual functions(1-7)

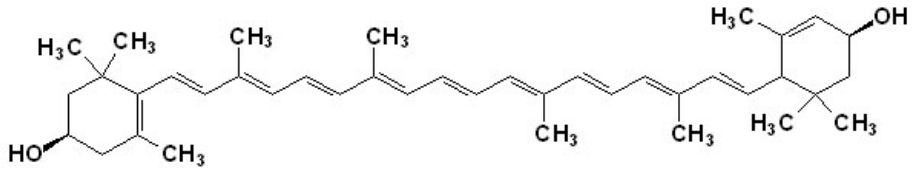
Visual Evoke Potential
measures the activity of the visual system



DHA is regarded as conditionally essential, especially early in life, due to the low ability in humans to convert it's precursor alpha-linolenic acid to DHA(8, 9)

1. Hoffman et al., 2000; 2. Guesnet et al., 2011; 3. EFSA 2009; 4. Birch et al., 2010; 5. Birch et al., 2011; 6. Drover et al., 2011; 7. Birch et al., 2000; 8. FAO 2010; 9. Pawlosky et al., 2001 .

Lutein in breast milk



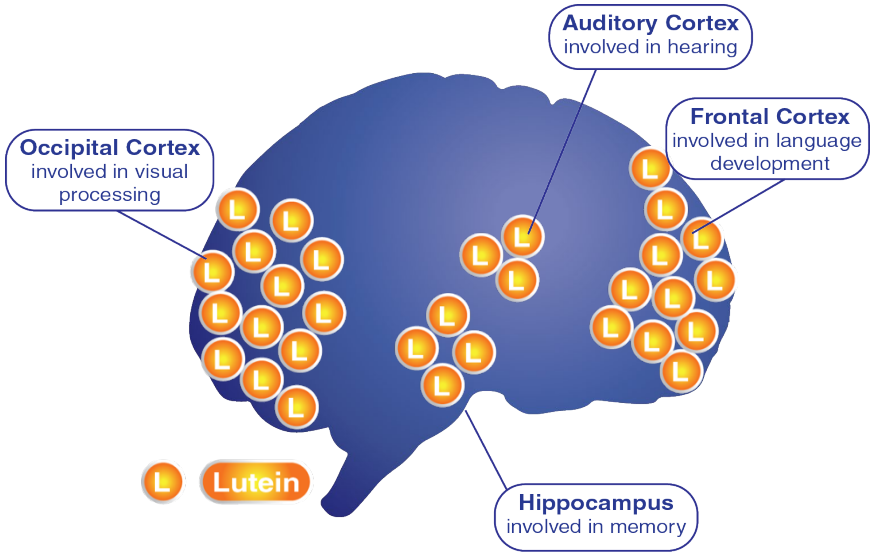
- Breast milk levels have been shown to be dependent on maternal dietary intake(1)

Country	Breast milk levels ug/L
Mexico	36.1 ± 17.6
Philippines	15.4 ± 14.6
Oman	29.0 ± 18.9
All countries	25.2 ± 18.9

- Lutein is a carotenoid that plays an important role as an antioxidant(2-4)

1. Pramuk et al., 2010
2. Johnson E., 2002
3. Winkler et al., 1999
4. Alves-Rodrigues & Shao 2004

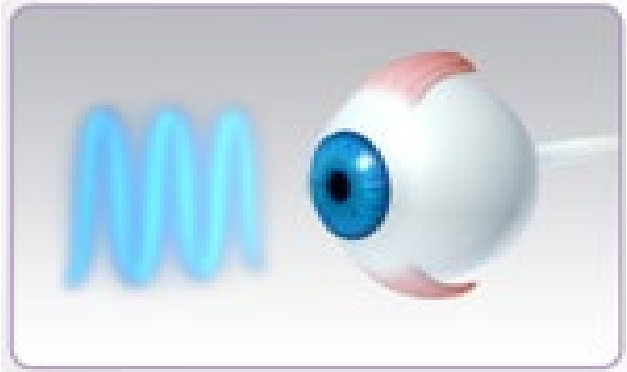
Lutein and brain



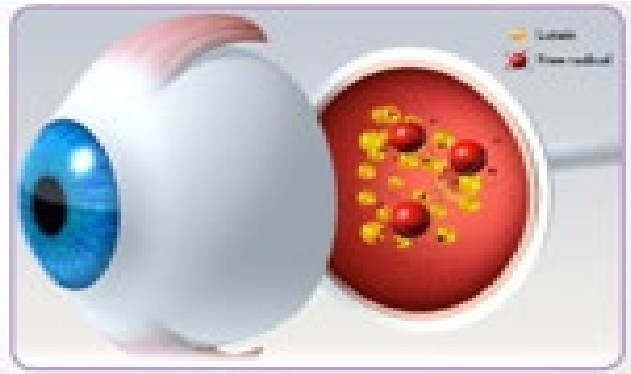
- Lutein is a major carotenoid found in the brain[1]
- In infants its been isolated from brain regions associated with cognition[2, 3]

1. Craft et al., 2004
2. Vishwanathan et al., 2011
3. Vishwanathan et al., 2014

Lutein and eye



Absorb potential damaging light



Lutein protect against oxidation

- Highly accumulated in the inner retina known to protect the eye from harmful light(1)
- Found in these high lipids areas, as an antioxidant it's been suggested to protect these areas against oxidative stress(1)

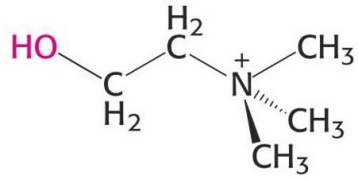
1. Snodderly D., 1995

Scientific evidence on lutein

- Early in life mode of feeding may influence lutein bioavailabity, whereby at least about ~4 times more lutein has to be in formula as compared to mean levels in breast milk to support similar infant plasma levels[1]
- In young adults 18-25yrs lutein mix supplementation resulted in increased macular pigment optical density and visual performance[2]
- In subjects ≥50 yrs, lutein composition in neural tissue and macular pigment had a positively correlated with cognitive function[3-6]

1. Bettelr et al., 2010; 2. Stringham et al., 2017; 3. Jonhnson et al., 2013.; 4. Vishwanathan et al., 2014; 5. Feeney et al., 2013; 6. Renzi et al., 2014;

Choline in breast milk



- Human milk levels have been reported to range with a mean estimated to be 160 mg/L[1, 2]

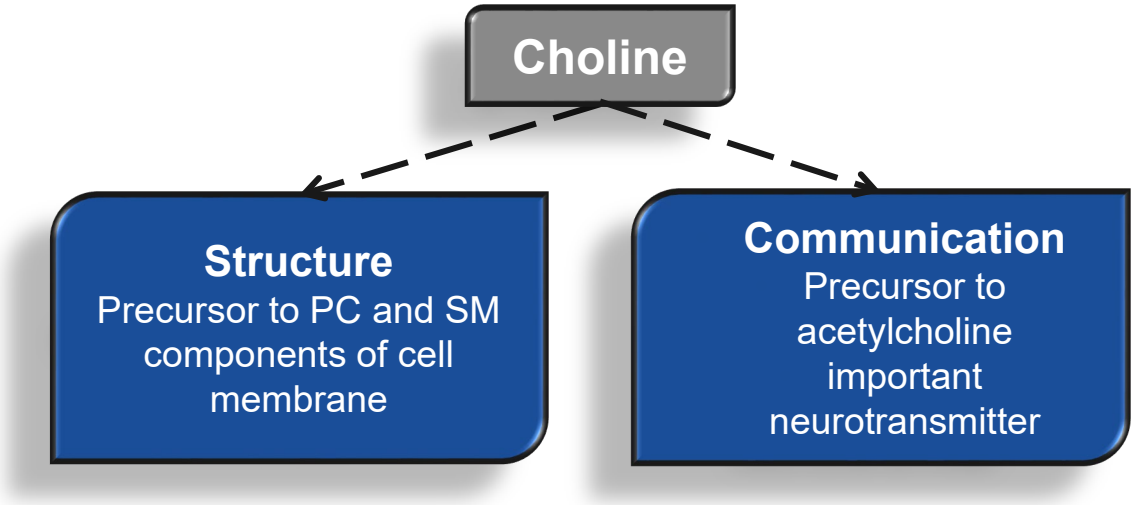
Human milk Sample	n	Total Choline µmol/L	Total Choline mg/L
Colostrum (0- 2 days	21	676 ± 35	70.42 ± 3.64
Mature milk			
12 – 180 days	95	1476 ± 48	153.75 ± 5
12 – 28 days	14	1595 ± 82	166.15 ± 8.54
75 – 90 days	12	1441 ± 84	150.12 ± 8.75
165 – 180 days	11	1349 ± 105	140.53 ± 10.94

- A water soluble vitamin with 3 main physiological functions, cell structure integrity, signaling role and a major methyl donor for methylation one of the key driver for biological reactions in the body[3, 4]

1. IOM 1998; 2. Ilcol et al., 2005; 3. Zeisel S., 2000; 4. Glier et al., 2014

Choline and brain

- Within the brain choline can be found incorporated into phosphatidylcholine (PC) and sphingomyelin (SM) which are components of cell membranes
- Choline is a precursor to acetylcholine a neurotransmitter, that travels across the synapse transmitting signals between neurons



1. Zeisel S., 2000
2. Zeisel S., 2006
3. Blokland A., 1996

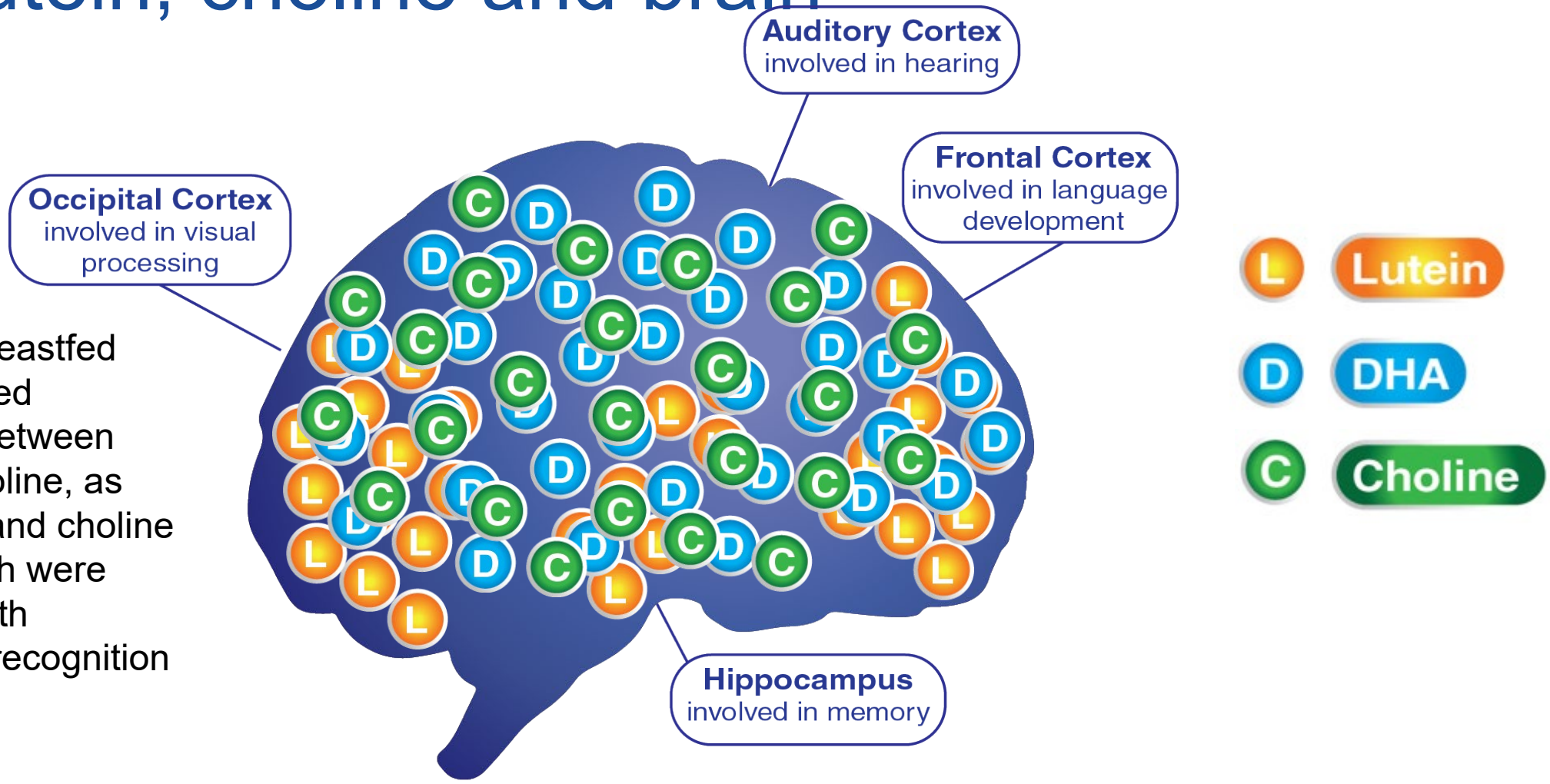
Scientific evidence on choline

- Maternal choline status in the first half of pregnancy has been associated with later cognitive development in healthy term-born infants[1]
- In toddlers, plasma betaine concentration (a product of choline oxidation) was positively associated with better visual-motor development[2]
- In adult and aged population cohort choline intake was related to better cognitive performance[3,4]

1. Wu et al., 2012
2. Wiedeman et al., 2018
3. Poly et al., 2011
4. Nurk et al., 2013

DHA, lutein, choline and brain

- A cohort of breastfed babies reported interactions between lutein and choline, as well as DHA and choline - both of which were associated with measures of recognition memory (1)



1. Cheatham & Sheppard 2015.

Adequate & balanced nutrition is critical to support rapid brain growth, development and long term cognitive abilities

DHA support brain/eye development and functional outcomes

Lutein an antioxidant protects both the brain and the eye

Choline a component of PLs vital for cell membrane and has a role in cell signaling, facilitating memory

DHA, lutein, and choline are found in the brain and may work in complement/together to support its development and function, both of which are vital for learning

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THANK YOU