MODULE TWO

Concentrated Phospholipid Krill Oil and Cognition

Lyso-PC–DHA transport, phosphatidylcholine, choline, astaxanthin neuroprotection

High-phospholipid krill oil for senior cognitive support

BEFORE WE BEGIN

Learning objectives

01 Explain how lyso-PC–DHA crosses the blood–brain barrier via Mfsd2a.

02 Describe how phosphatidylcholine becomes the transport-competent lyso form.

03 State the dual role of phosphatidylcholine: membrane lipid and acetylcholine precursor.

04 Describe astaxanthin neuroprotection: mitochondria, microglia, and BBB transit.

05 Apply cognition-range EPA/DHA doses and monitor with the Omega-3 Index (dogs only).

Cognitive signs of aging

What it is

Normal aging changes in attention, memory, and sleep–wake patterns that may or may not progress to clinically significant cognitive decline.

Common changes

Reduced activity initiation, altered nighttime settling, less interest in meals or play, slower response to name or familiar cues, and quieter greeting behavior.

What owners notice

Disorientation in familiar settings, changes in sleep–wake cycle, reduced social interaction, or house-soiling in previously trained dogs.

Next step

These signs warrant veterinary evaluation to rule out pain, sensory loss, metabolic disease, or other differentials.

DHA in the aging brain

Dominant LC-PUFA

DHA is the predominant long-chain omega-3 in neuronal and synaptic membranes.

Function

Membrane fluidity, synaptic plasticity, receptor function, and neurotransmission all depend on adequate DHA.

Aging change

Brain DHA content declines with age. Supplementation can restore membrane composition.

Behavioral signal

Aged dogs show better discrimination learning, reversal learning, and spatial memory at higher DHA intakes.

Lysophosphatidylcholine–DHA and Mfsd2a

- DHA esterified to lysophosphatidylcholine (lyso-PC–DHA) is the form most efficiently taken up across the blood–brain barrier.
- Transport is via Mfsd2a, a sodium-dependent symporter on brain endothelial cells.
- Non-esterified DHA can also enter the brain by other routes; Mfsd2a specifically transports LPC-bound DHA.
- This is the major characterized pathway for brain DHA uptake.

REMEMBER THE NAME

Mfsd2a

Major facilitator superfamily domain-containing 2A.

If they remember one protein from this module, this is the one.

Neonatal brain accretion

Breast milk

Human milk DHA is mostly triglyceride-bound; the small phospholipid fraction is efficiently enriched in the developing brain (experimental models).

Formula gap

Formula-fed infants show lower brain DHA accretion than breast-fed infants — attributable to total DHA intake, not the lyso-PC fraction specifically.

Krill alignment

Krill oil provides DHA esterified in phosphatidylcholine, which gut and liver can convert to the lyso form that crosses the BBB.

Why seniors care

The same transporter and the same cargo operate in the adult brain. Neonatal biology is the cleanest illustration of the pathway.

Phosphatidylcholine: membrane and acetylcholine

STRUCTURAL ROLE

Phosphatidylcholine is the principal phospholipid of neuronal membranes. Membrane synthesis and repair in an aging brain consume PC continuously. Supplying PC is supplying the bilayer, not only the fatty acid attached to it.

CHOLINERGIC ROLE

PC supplies choline, the substrate for acetylcholine synthesis. Acetylcholine is the transmitter most implicated in memory and attention. In the aging brain, membrane turnover continues while cholinergic tone declines — both argue for adequate choline.

From phosphatidylcholine to lyso-PC–DHA

1

Gut

Pancreatic PLA2 cleaves the sn-2 acyl chain of krill PC → lyso-PC + free fatty acid.

2

Reacylation

Enterocytes and liver reacylate lyso-PC to circulating lipoprotein-bound PC.

3

At the BBB

Circulating lyso-PC–DHA is generated largely by the liver; Mfsd2a at the BBB transports it (immediate endothelial regeneration is proposed, not established).

4

Fit to enzyme

Krill DHA is enriched at sn-2; retaining it on lyso-PC requires removal of the other acyl chain (PLA1-type activity or remodeling) — the full sequence is not yet demonstrated in dogs.

Mechanisms shown are drawn from rodent and human data; the gut-to-BBB sequence has not been demonstrated in dogs.

Choline requirements for cognitive support

- Choline is essential. Endogenous synthesis does not cover demand when membrane turnover and acetylcholine synthesis are both high.
- The aging brain increases both of those demands at once.
- Phosphatidylcholine from concentrated krill oil is a bioavailable choline source, not only an EPA/DHA vehicle.
- Use the product label choline estimate when you counsel owners — do not invent a milligram figure from human RDA tables.

PRODUCT COA

Choline content: check the COA

Check whether the current-lot COA at www.krilpet.com (3rd Party Testing) reports choline; otherwise obtain verified content from the manufacturer before counseling owners.

STILL RELEVANT IN MODULE TWO

Astaxanthin neuroprotection

BBB transit	Astaxanthin crosses the blood–brain barrier and accumulates in brain tissue (rodent data).
Macromolecules	Reduces oxidative damage to neuronal lipids and proteins (rodent and in-vitro data).
Microglia	Attenuates microglial activation and the associated neuroinflammatory cascade (rodent data).
Mitochondria	Protects neuronal and astrocytic mitochondria (proposed mechanism).
Aging models	Improves memory and reduces amyloid-β pathology in rodent models; canine cognitive benefit is not established by the cited evidence.

Mitochondrial protection in neurons

Where it sits

Spans lipid bilayers, including mitochondrial membranes.

What it does

Scavenges superoxide and other ROS at the site of generation, not after they have left the organelle.

ATP

May preserve oxidative phosphorylation under inflammatory and oxidative load (proposed mechanism).

Cell fate

Reduces the likelihood of mitochondrial permeability transition and downstream neuronal apoptosis (proposed mechanism).

Dosing for cognitive support

DOSES USED IN INDIVIDUAL TRIALS

Published studies used differing EPA/DHA doses, often in multinutrient diets. These are not established stand-alone krill-oil dosing recommendations.
Review-wide cognition doses span 7–94.5 mg/kg EPA/DHA — individual trial doses, not an established effective range.

HOW TO COMBINE

The strongest trials used multinutrient diets (vitamins E and C, EPA/DHA, B vitamins, arginine, MCTs) — benefit cannot be attributed to omega-3s alone.

DHA is the principal omega-3 of interest for the brain.

Allow 8–12 weeks before judging effect. The index reaches its new level at 3–4 months. Stay under the NRC safe upper limit for total EPA+DHA from food plus supplements — 370 mg/kg^0.75/day (dogs only; no feline limit exists). High study doses are not automatic starting doses.

WHAT TO PUT ON THE SHELF

Concentrated phospholipid krill oil

High phospholipid content

High phospholipid content — the substrate pool from which lyso-PC–DHA can be generated (mechanistic rationale; the cited evidence does not establish this product's canine cognitive benefit).

Verified label

EPA, DHA, phosphatidylcholine, and choline — confirm values against the COA (www.krilpet.com, 3rd Party Testing).

Oxidation testing

Peroxide and anisidine values. PUFA that oxidizes before it arrives is wasted cargo.

Senior indication

Positioned for cognitive support; do not substitute the high-astaxanthin joint oil and call it equivalent.

Diet accounting

Senior and brain-support diets may already contain marine oil. Add, don't stack blindly.

Monitoring

Baseline OmegaQuant (dogs only), recheck at 3–4 months for index steady state, then 3- and 6-month clinical review.

Clinical integration

01 **Baseline**

Omega-3 Index (dogs only) plus a structured cognitive screen (DISHAA or equivalent) and owner video if possible.

02 **Start**

Concentrated phospholipid krill oil at a conservative cognition-range dose. Review current diet omega-3s.

03 **Support**

Environmental enrichment, exercise as tolerated, antioxidant- and B-vitamin–aware diet.

04 **Recheck**

8–12 weeks for index and early owner report. Formal reassessment at 3 and 6 months.

TAKE HOME

Module Two in five lines

1. Lyso-PC–DHA crosses the BBB via Mfsd2a — the same route that supplies the neonatal brain.
2. High-phospholipid krill oil supplies PC; gut and liver can generate the lyso form. Krill DHA sits at sn-2; the full conversion sequence is not yet demonstrated in dogs.
3. Phosphatidylcholine is both membrane material and a choline source.
4. Astaxanthin still matters: BBB transit, microglial tone, and mitochondrial ROS (rodent data).
5. Dose in published trial ranges, pair with a multinutrient approach, and monitor with OmegaQuant (dogs only).

Selected references

Blanchard T, et al. (2025). Enhancing cognitive functions in aged dogs and cats: a systematic review of enriched diets and nutraceuticals. GeroScience 47:2925–2947 — https://pmc.ncbi.nlm.nih.gov/articles/PMC12181554.

Mfsd2a and lysophosphatidylcholine–DHA transport literature (Nguyen / Silver and subsequent work) — e.g., https://pmc.ncbi.nlm.nih.gov/articles/PMC6476709.

Astaxanthin neuroprotection: rat brain accumulation — https://pmc.ncbi.nlm.nih.gov/articles/PMC9435021; aged-mouse cognition — https://pmc.ncbi.nlm.nih.gov/articles/PMC6423184; APP-model mice — https://www.frontiersin.org/journals/pharmacology/articles/10.3389/fphar.2020.00307/full (rodent data).

National Research Council. Nutrient Requirements of Dogs and Cats (2006). Safe upper limit for EPA+DHA in dogs (no feline limit set) — see Lenox & Bauer, JVIM 2013: https://doi.org/10.1111/jvim.12033.

Human-milk lipid composition (OCL review — https://www.ocl-journal.org/articles/ocl/full_html/2020/01/ocl190063/ocl190063.html), used here as mechanistic analogy (milk DHA is mostly triglyceride-bound).